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ABSTRACT

This curriculum consists of a Teacher's Guide and a series of 12 instructional modules, that are centered around concepts important in the study of national resource science. The modules are designed to supplement textbooks with activities for students in primary and middle grades (K-8). The titles of the modules are: (1) Natural History of a Tree; (2) Soils and Plant Growth; (3) The Water Cycle; (4) Recipe for Tree Growth; (5) Tree Growth and the Environment; (6) Appreciation of Natural Beauty; (7) Forest Processes; (8) Growth of a Forest; (9) Interactions of Forest Plants and Animals; (10) Managing Our Forest Resources; (11) Natural Watersheds; (12) Managing Our Natural Resources. The materials are designed to address concerns with the environment and stewardship of the planet via teaching of higher order thought processes, and fostering meaningful learning. The instructional sequence uses the learning cycle approach to teaching. For each module the three phases of the learning cycle are specified: exploration phase, wherein students explore new ideas with minimal expectation of specific accomplishment; the inventing an idea phase, during which the new idea or skill is formally introduced; and the expansion phase, which provides practice and transfer situations. The following information is provided for each module: background information, objectives, three learning phases, evaluation, glossary and figures for transparencies, student handouts and concept maps. (Author/MCO)

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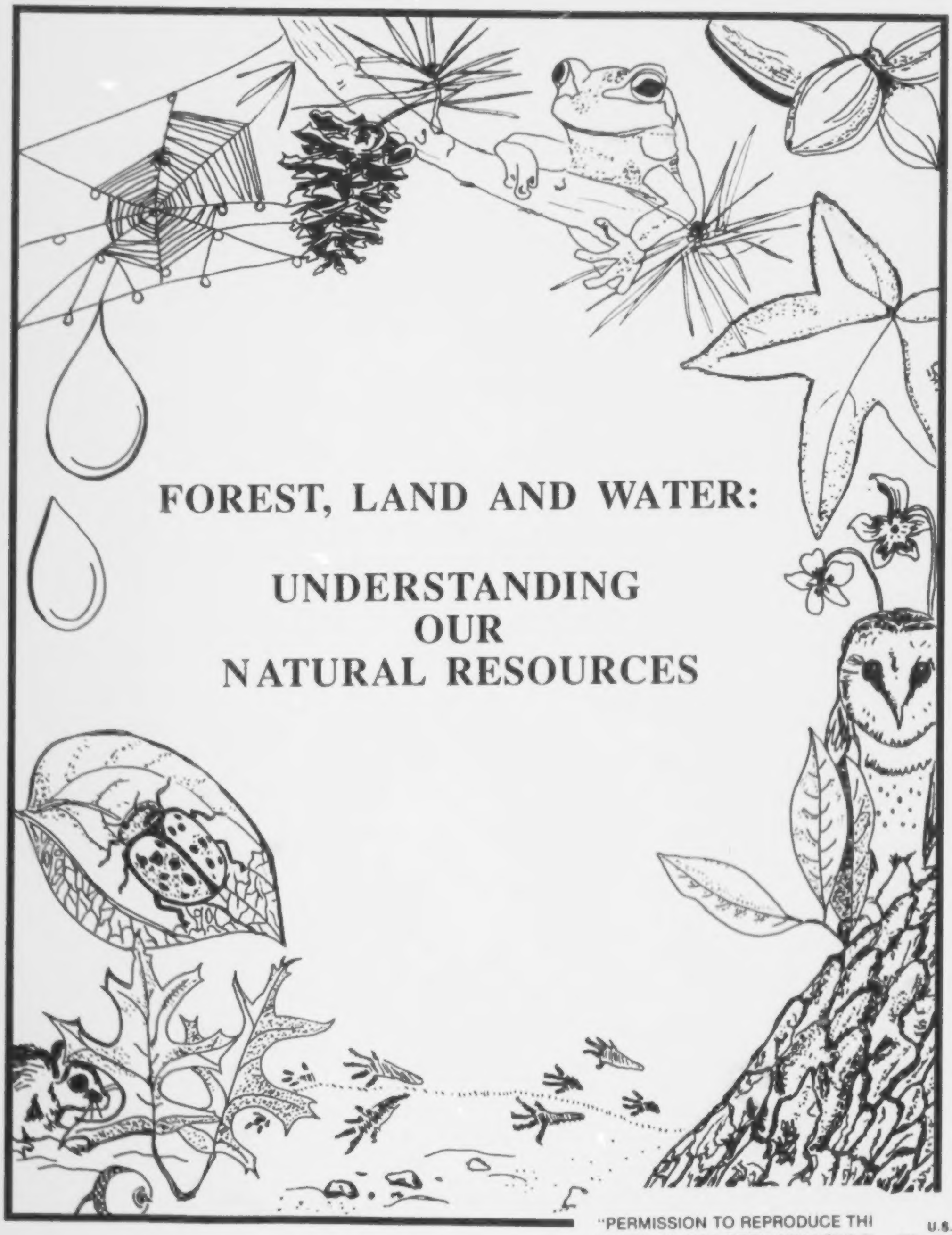

FOREST, LAND AND WATER:

UNDERSTANDING OUR NATURAL RESOURCES

SE053247

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The writing, development and, production of the *NATURAL RESOURCES EDUCATION SERIES* is a joint project with collaboration of project directors Dennis W. Sunal, The University of Alabama, and Mary E. Haas, West Virginia University, and the U.S. Forest Service. Partial funding was provided by the U.S.D.A. Forest Service. The initial author and series editor was Dennis W. Sunal. Revision of individual modules was carried out with the help of Mary E. Haas, and Cynthia S. Sunal. Assistance in creating appropriate activities, proof reading, and creating art work by computer for the many editions was provided by Jon Berninzoni, Elwin Dickerson, Tracy Johnson, Jane McGinnis, and Sukhwindar Singh. Final editing assistance on the text and artwork was performed by Audrey Rule. William Kline, Jr. assisted in training the original trial teachers. Content reviewers were specialists in the various module topics at the U.S. Forest Service including Monongahela National Forest staff members, Theresa Anne, Randolph Harrison, Linton Wright, and Harry Mohoney, and Northeastern Forest Experiment Station, Timber and Watershed Laboratory staff Pamela Edwards, David Helvey, James Kochendorfer, and Clay Smith. Teachers in the Randolph County, West Virginia Schools who first taught the modules and made recommendations for revisions were: Sandra Arbogast, Sara Basil, Ann Deloach, Karen Hall, Richard Leitner, Elizabeth McDonald, Linda Moore, Sharon Moss, Pam Mullennex, Jeff Ranhart, Theresa Skidmore, Rachel Snavely, Charles Swecker, Nancy Taylor, Angela Vance and Rebecca Wallace.

The *NATURAL RESOURCES EDUCATION SERIES* is designed to supplement textbooks with active learning lessons for students in the primary and middle childhood grades (K-8). The series consists of a Teachers Guide and 12 Modules. The titles include;

Natural History of a Tree
Soils and Plant Growth
The Water Cycle
Recipe for Tree Growth
Tree Growth and the Environment
Appreciation of Natural Beauty
Forest Processes
Growth of a Forest
Interactions of Forest Plants and Animals
Managing Our Forest Resources
Natural Watersheds
Managing Our Natural Resources
Forest, Land and Water: Understanding Our Natural Resources - Teacher's Guide

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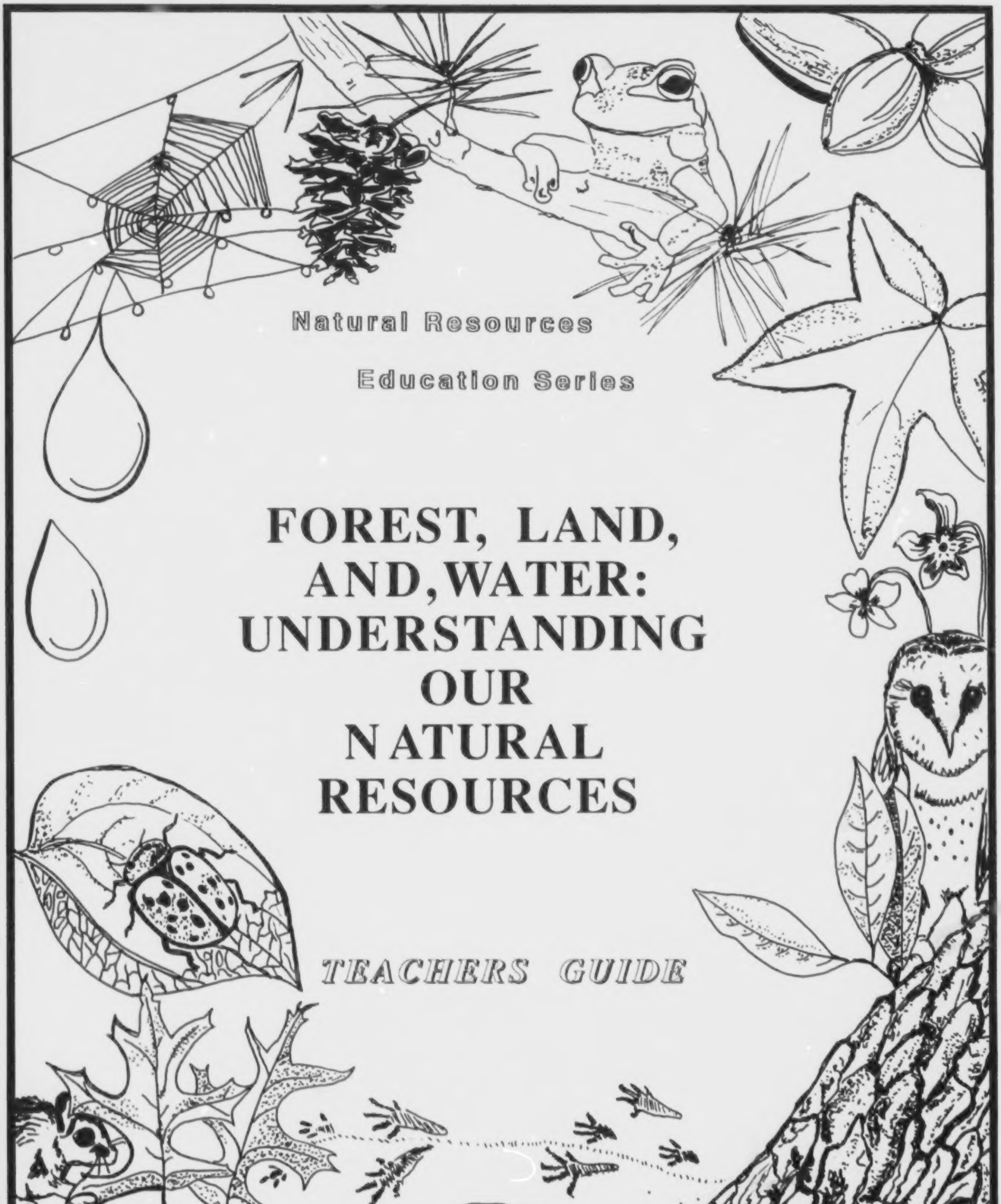

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FOREST, LAND, AND, WATER: UNDERSTANDING OUR NATURAL RESOURCES

TEACHERS GUIDE

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FOREST, LAND, AND WATER: UNDERSTANDING OUR NATURAL RESOURCES

Teachers Guide for the Natural Resources Education Series

BACKGROUND INFORMATION FOR TEACHERS

Natural resource science includes those features of the earth and its products which support life and satisfy human needs. The focus in this series is on land and water resources, their interrelationships and their importance to human survival and fulfillment. The natural resource science curriculum **Forest, Land, and Water: Understanding our Natural Environment** was developed through the Natural Resource Science Curriculum Project over a six-year writing and field testing period. The curriculum materials were designed to address present concerns with the fragile earth environment and our stewardship of the planet. This stewardship involves positive efforts in developing appropriate knowledge, actions, and attitudes. The materials, in addition, incorporate teachers' concerns about how children learn, teaching for higher order thought processes, and fostering meaningful learning in students in the early and middle childhood, K-8, grade levels.

PURPOSE

A primary goal of the project was the development of teacher materials that enhance the natural resource science already taught in the regular school science curriculum. These science materials provide learning activities which support and extend, through concrete experiences, specific science topics found in today's science curriculum guides, textbooks, and teacher-planned science units. The curriculum materials are centered around a hands-on/minds-on discovery learning sequence and content of instruction that:

- enhances student understanding of the interaction between natural resources, ecosystems, and human needs;

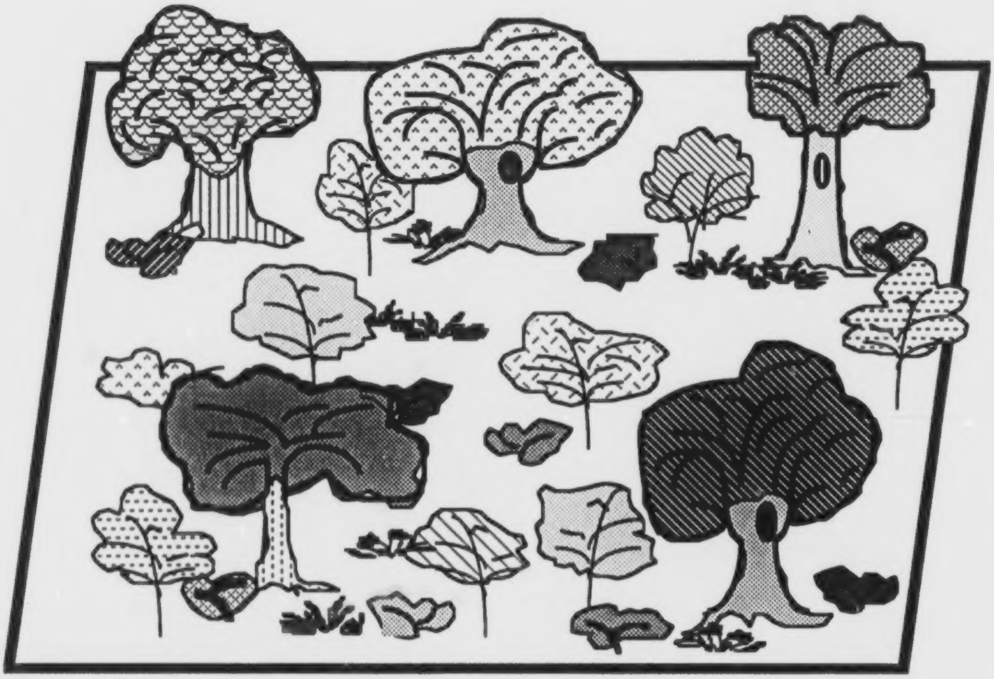
- encourages student concern in developing and sustaining appropriate use of natural resources;

- provides learning situations that promote student use of critical thinking about natural resource concepts, sequences, and processes; and

- increases student awareness of the diversity of career options available involving the natural resource sciences.

In addition, these curriculum materials provide experiences in instruction centered on helping students develop:

- awareness of environmental adaptation in all species;
- respect for the life enhancing role of natural resources;
- an attitude toward acceptance of life and death cycles in nature as well as with people; and
- appreciation for the beauty of the natural environment and its resources.



* Illustration taken from Natural Resources Education Series Module "**Interactions of Forest Plants and Animals,** Wildlife in the Forest Community".

THE FOREST, LAND, AND WATER CURRICULUM

The Forest, Land, and Water: Understanding Our Natural Resources curriculum consists of a series of instructional modules, **Natural Resources Education Series**, each of which is centered around a concept important in the study of natural resource science. The level of instruction of these materials is for students in the early and middle childhood grades, ages 5-14. The curriculum involves extensive student activity and was designed for use by teachers as well as other adults in community teaching roles. The activities involve the use of classroom materials brought in from the outside and use of the local environment surrounding the school during short field trips.

The curriculum is unique in that it does not just provide teachers with an objective and a brief activity description. Instead, the curriculum modules offer complete lessons and help in integrating them into the planned classroom science curriculum. The modules can be used in any sequence. They can be integrated into existing science textbook chapters as a single lesson or as a set of lessons at appropriate times. The modules also may be used as short, intact science units of a few days length. Beginning with a discussion of science background important to the concept, each module provides descriptions of objectives, materials, instructional procedures, media masters, student handout sheets, ideas for evaluation, and other educational resources. Many optional activities are included so that the teacher may select a set of activities appropriate for his or her students.

The curriculum, as a whole, is designed to provide students with a greater understanding of natural resource science, the importance of natural resources to their lives, and career options available. The curriculum provides teachers with extensive hands-on activities, science information on natural resource concepts, related measurement skills, and interpretation techniques in a complete lesson plan format.

SCHEDULE OF PROJECT ACTIVITIES

1987

- assessment of student knowledge and attitudes toward basic concepts involved in the natural resource sciences
- assessment of science curricula in schools
- selection of basic natural resource science concepts appropriate for existing science curricula found in the early and middle childhood grade levels

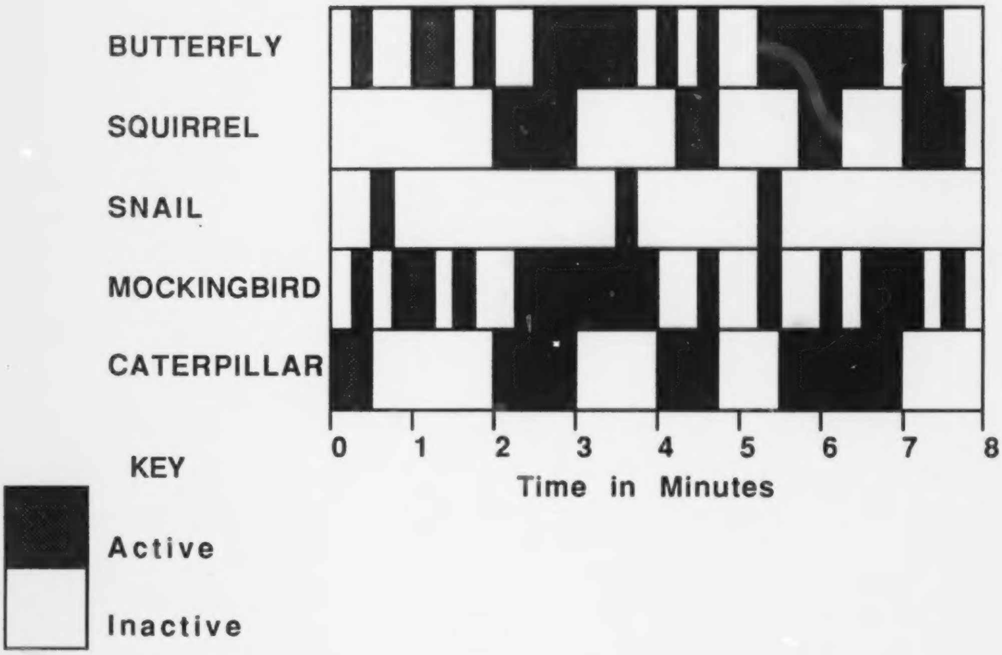
1987 - 1988

- writing and revision of trial curriculum modules
- evaluation of trial modules in classrooms
- evaluation of the natural resource science content by science and education experts involved in research, management, and curriculum development

1988 - 1991
- teacher inservice training activities in school systems
- creation of a classroom network of users of **Forest, Land, and Water: Understanding Our Natural Resources**
- editing and rewriting of trial module edition

1991 - 1992
- national dissemination of **Forest, Land, and Water: Understanding Our Natural Resources** curriculum materials

Figure 1. ANIMAL MOVEMENT



* Illustration taken from Natural Resources Education Series Module "**Interactions of Forest Plants and Animals,** Wildlife in the Forest Community".

INSTRUCTIONAL MODULES IN THE CURRICULUM

The Natural Resources Education Series includes 12 modules and a teacher's guide introducing the series. The titles of the modules are:

Natural History of a Tree: Happy Birthday How Old are You?

Soils and Plant Growth: A Dirty Business

The Water Cycle: Our Water Carnival

Recipe for Tree Growth: Sun Baked Tree'ats

Tree Growth and the Environment: The Local Tree Community

Appreciation of Natural Beauty: Oh Beautiful, for Spacious Skies

Forest Processes: Fire, Animals, and the Forest

Growth of a Forest: Forests Do Change Too!

Interactions of Forest Plants and Animals: Wildlife in the Forest Community

Managing Our Forest Resources: How Do We Take Care of a Forest?

Natural Watersheds: The Water We Drink and Use -Where Does It Come From?

Managing Our Natural Resources: Would You Like a Career Involving Natural Resources?

Forest, Land and Water: Understanding Our Natural Resources, Teacher's Guide for the Natural Resources Education Series.

USING THE MODULES

OBJECTIVES FOR THIS SECTION OF THE TEACHERS GUIDE

-Describe how the **Forest, Land and Water** modules are designed to develop a practical understanding of natural resource science concepts and stewardship attitudes and actions.

-Describe the purpose of the learning strategy, the *learning cycle*, used to sequence learning in the **Forest, Land and Water** modules.

-Identify and describe the three phases of the *learning cycle* incorporated in the **Forest, Land and Water** modules.

-identify, and describe the purpose of each of the major parts of the **Forest, Land and Water** modules.

-Describe decisions necessary to integrate a **Forest, Land and Water** module into a science textbook chapter or a science unit plan of study with the intent of enhancing meaningful learning of natural resource science ideas and skills.

INSTRUCTIONAL SEQUENCE IN THE MODULES

This Teacher's Guide introduces the curriculum organization and instructional sequence of **Forest, Land, and Water: Understanding the Our Natural Resources.** The following readings and tables will acquaint teachers with the organization of each module and to help teachers effectively integrate the natural resource science lessons into their classroom science curriculum. While reading through this next section of the Teacher's Guide you may wish to make notes or underline key ideas for future reference. The following information focuses on the overall purpose of the instructional sequence found in the modules - fostering students' construction of meaning and the *learning cycle.*

The central question raised in designing these curriculum materials is, "How can we assist students in meaningful learning of important natural resource science content? Before describing specific teaching procedures that can be especially valuable, it is important to take a closer look at the way children learn, the process of constructing meaning through interacting with objects and events. This process is essential to the formation of new concepts and generalizations and in developing higher levels of student thinking (Saunders, 1992). The learning sequence described here, the *learning cycle* approach to teaching, encourages meaningful science learning by students (Karplus, 1979). This is a hands-on/minds-on approach to learning. Making students aware of their own reasoning, by helping students' reflect on their activities, is an important part of this teaching approach. The *learning cycle* approach is most effective when used as part of an instructional program that also stresses creativity, development of self-worth, self-reliance, and respect for the opinions of others.

The *learning cycle* approach has been used effectively with students at all levels. The purpose is to help students develop new knowledge and reasoning patterns in one or more areas. This is done by providing a set of experiences which are focused on helping students construct their own knowledge and giving them time to do it before they are given an explanation (Sunal, 1992). The approach also asks students to apply their newly gained knowledge before the lesson is concluded and lesson evaluation begins. The advantage in using this approach is that the student is more likely to engage in applying knowledge in a new area because she is aware of her own reasoning, can recognize its shortcomings, apply procedures successful in other areas, and can search more effectively for new patterns. To be helpful, an instructional sequence must strengthen these tendencies in all students and discourage unquestioning acceptance of poorly-understood principles and procedures.

Traditional teaching of science usually begins with telling students what they are to know, showing students examples of the science to be described, and using motivational techniques to keep them on task long enough to be able to complete the lesson. The result of this type of teaching may be somewhat effective for fact memorization. However, it consistently gives inadequate results with students when the objective is a science concept, attitude, or thinking skill (Sunal, 1992).

The *learning cycle* is designed to help students construct their own meaning, connect it to what they already know, and apply this new knowledge in ways that are different from the situation in which it was learned. Thus the *learning cycle* involves students in a sequence and set of procedures which:

-- begin with student exploration of ideas and skills to be learned,
-- lead to a more teacher guided explanation, invention, of the ideas or skills, and
-- culminate in expanding the idea through additional practice and applications in new settings outside of the original lesson activities.

These three phases of the complete *learning cycle* are called the:

1) **EXPLORATION PHASE,**
2) **INVENTING THE IDEA PHASE, and**
3) **EXPANDING THE IDEA PHASE.**

During the **Exploration Phase**, the students must learn through their own actions and reactions in a new situation. In this phase they explore new materials and new ideas with minimal guidance or expectations of specific accomplishments (Sunal, 1992). The new experience should raise questions that they cannot answer with their accustomed patterns of reasoning. For many students, having made an effort that was not completely successful will help them to be ready for learning in a more guided explanation which occurs next in the **Inventing the Idea Phase** of the lesson.

The second phase of a lesson built on the *learning cycle*, the **Inventing the Idea Phase**, formally introduces the new idea or skill that leads the students to construct new knowledge (as compared to the idea the students started the lesson with) from their experiences. The concept may be introduced by the teacher, the textbook, a film, or another medium. This learning phase should always follow the **Exploration Phase**. Students should be encouraged to construct as much of the new idea as possible themselves in the **Exploration Phase** of the lesson before it is explained to the class. However, expecting students to form all complex ideas themselves is not always possible. Invention activities should naturally relate to the questions the students were asking themselves at the conclusion of the **Exploration Phase**. The students own questions are now being answered in an effective **Invention**.

In the **Expanding the Idea Phase**, the last part of any effective lesson designed to teach ideas and skills meaningfully, the students should apply the new idea in additional situations. The **Expansion** part of any lesson plan is necessary to extend the range of applicability of the new idea. The **Expansion** provides additional time and experiences to stabilize the new idea or skill as a mental construct. Without a number and variety of applications, the idea's meaning will remain restricted to the examples used during its definition. Many students may fail to abstract the idea, lesson concept, from its concrete examples or may generalize it to other situations. Asking the students to construct their own models or measure other examples of the main lesson idea and interpret its meaning are possible **Expansion** activities. Expansion activities also help students whose learning takes places more slowly than average, or who did not adequately relate the teacher's original explanation to their own experiences.

The *learning cycle*, is based primarily on developmental concepts of learning bus also incorporates the results of information processing research.. Thus, the **Exploration Phase** permits learning by allowing students to use their previous knowledge, be confronted with the inadequacies of that knowledge, and make their own new knowledge through discovery. The **Invention Phase** allows learning from guided experience based on connections made to previous knowledge during the **Exploration** part of the *learning cycle*. The **Expansion** provides needed practice and transfer situations to help stabilize the thought process learned for long term memory. Meaningful learning only takes place in a fully complete *learning cycle*. If a phase is eliminated or all students are expected to demonstrate specified uniform outcomes after the first or second phase of the cycle, then the overall effectiveness of the *learning cycle* will be compromised. A summary of the characteristics of the *learning cycle* is given at the end of this Teachers Guide in table 1.

MODULE ORGANIZATION

As an example of the *learning cycle* and of the organization of the curriculum, direct your attention to the **Natural Resources Science Education Series** of modules. Look at a copy of one of the modules. Quickly skim through the module looking at major headings and activities following each heading. You will note that the modules do not begin student activities with a definition of the idea and skills involved in the lesson. The student module activities first place students in a situation where they must consider alternative ideas for causes of patterns they identify based on their own experiences and expectations. That serves as the **Exploration Phase**. Next, the module activities involve students in concrete explanations of concepts and patterns supported by evidence along with necessary terminology following experiences with the terms. These activities are found in the **Inventing the Idea Phase** of the lesson. The **Expanding the Idea Phase** of the lesson allows students to practice the lesson's ideas and skills in similar and in different contexts. Evaluation activities follow the **Expansion**.

To get an overall view of the **Forest, Land and Water** module format, an outline around which all of the modules were designed is shown in Table 2 at the end of this Teachers Guide. The unbolded sections are for teacher background and help in preplanning for the lessons. The **bolded** sections represent possible student activity during the lesson. Teachers have reported an effective procedure for getting acquainted with a new module. They find that reading the first paragraph in the Background section and then immediately turning to the Objectives provides a quick overview to the module. Comparing this information with your state or local curriculum and your science textbook will allow you to determine whether there is a match.

If the module appears to meet your curriculum goal the next step would be to review the activities designed for the level of your students. Not all student activities are needed in a lesson, many are optional. Select those which best fit your classroom and curriculum. You must, however, select at least one activity for each phase for effective learning of the main lesson objectives. It is important at this time to read the entire Background section. This will provide additional information you can use to make your choices of activities. After selecting the activities which would complete a full learning cycle gather the materials needed, begin planning for long-term growth of plants (if needed), and identify possible field trip sites (if such sites are needed for the activities you have chosen). As you begin teaching the activities you will find the student handouts to be quite effective. Suggestions for lesson and unit student evaluation are provided in each of the modules. Teachers have found that Expanding the Idea activities suggested in the module but not selected as part of the lesson, are excellent for evaluating higher order student thought processes.

SUMMARY STEPS FOR INTEGRATING THE MODULES WITH SCIENCE TEXTBOOKS AND PREPARED SCIENCE UNITS

1. Search, select, and list your science textbook chapters or classroom science curriculum guide for topics related to natural resources science ideas and skills. See the Natural Resources Education Series list of modules on page 5 of this Teachers Guide for help in making this selection.

2. Organize the selected science textbook chapter or classroom science unit so it follows a progression from concrete to more complex natural resource science ideas and skills.

3. Be aware that the worthwhile objectives (concepts, generalizations, actions, and thinking skills) of the natural resource science topics you teach require require a different strategy of instruction from the traditional approach of telling, reading and showing. Identify these topics in advance and if appropriate, at this point integrate a **Forest, Land and Water** Module with the science textbook chapter or classroom science unit.

4. Read the Teachers Guide ahead of time so that materials can be secured from the local community and field trip sites around your school can be identified.

5. While teaching demonstrate a questioning and reflecting attitude towards the science you teach. Generate hypotheses, examine alternative explanations and encourage your students to do the same. Reward this type of behavior in your students.

6. Your science textbook should be used with a **Forest, Land and Water** module as a resource during the **Inventing the Idea Phase** of the lesson, if similar topics are covered.

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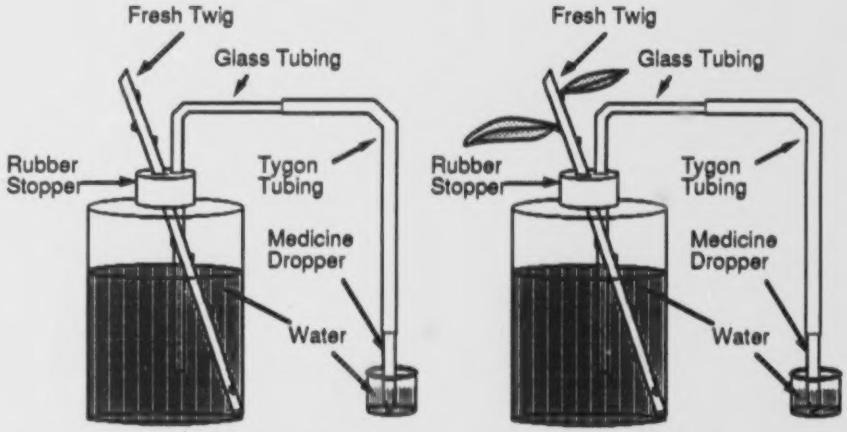

Fresh Twig
Glass Tubing
Rubber Stopper
Tygon Tubing
Medicine Dropper
Water
Fresh Twig
Glass Tubing
Rubber Stopper
Tygon Tubing
Medicine Dropper
Water

Twig 1 - without leaves

Twig 2 - coated with wax or oil

* Illustration taken from Natural Resources Education Series Module "**The Water Cycle,** Our Water Carnival".

Table 1
Sequencing Instruction - The Learning Cycle

Exploration Phase

Purpose -to provide background experience and learning through students' own actions and reactions and to introduce aspects and values of a new concept, variable, or skill (enhances assimilation). Exploration allows children to confront and make evident their own thinking/representation of the concept or idea to be taught

Characteristics:
1. Allows learning by student's own inquiry
2. Minimal guidance or expectation on the teacher's part
3. Confrontation experience to students old way of thinking, if possible
4. Raises questions for the students
5. Student action with hands-on materials
6. Provides adequate time to get acquainted with concept or skill

Inventing the Idea Phase

Purpose - Introduction of a new concept or situation that leads students to apply new patterns or reasoning to their experiences. Invention builds on the Exploration by guiding the children in a more direct teaching format, to experience and develop the concept more fully or to a higher order.

Characteristics:
1. Follows an adequate exploration where some development of an idea or skill (reasoning pattern) may have occurred
2. Allows learning from "explanation" which includes an interesting variety in teaching methods and student behaviors.
3. Introduces an idea or skill in a structured manner through additional experience using a variety of sense modalities, teacher explanation, film, textbook readings, or other medium.
4. Encourages students to develop as much of the idea and reasoning pattern as possible.

Expanding the Idea Phase

Purpose -Apply new concept or reasoning pattern to additional example(s) to help stabilize thought process (provides a stable mental organization): Expansion activities allow the children to practice the idea or skill just taught in the Invention. If possible include experiences during the practice which cause the children to extend the range, modality and context of the idea or skill.

Characteristics:
1. Provides for learning by repetition.
2. Provides additional time and experiences for the idea or skill to become part of the student's thought processes (self-regulation).
3. Encourages development of long term memory by helping abstraction from concrete examples.
4. Extends the range of applicability of the new reasoning pattern outside of the learning setting by transfer to other times or contexts

Table 2
Natural Resource Science Curriculum Module Format

Title
Background Information for Teachers
Objectives

EXPLORATION PHASE
To the Teacher
Early Childhood Activities
    Materials
    Involve the Students in the Following Activities
    Possible Optional Activities

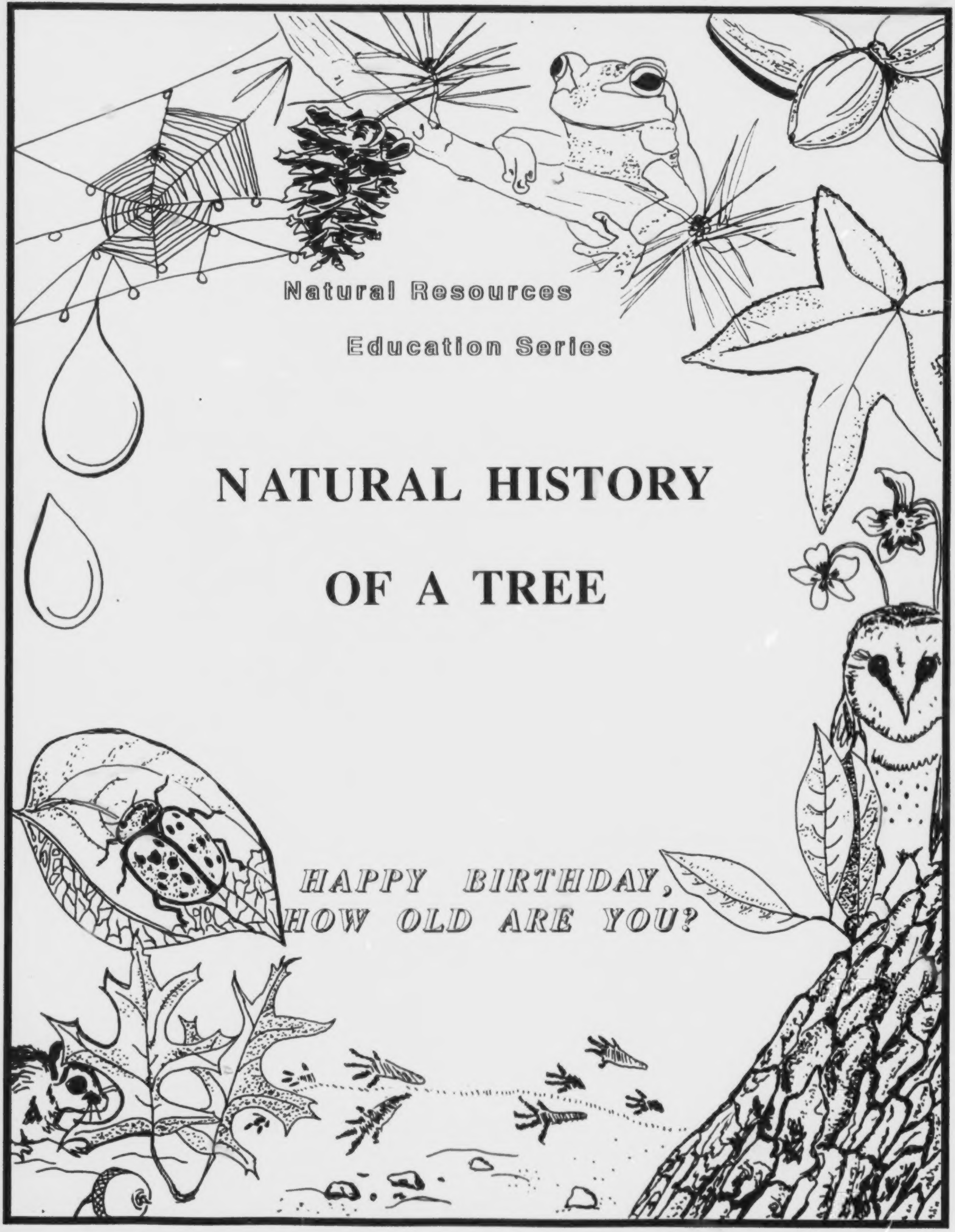
Middle Childhood Activities
    Materials
    Involve the Students in the Following Activities
    Possible Optional Activities

INVENTING THE IDEA PHASE
To the Teacher
Early Childhood Activities
    Materials
    Involve the Students in the Following Activities
    Possible Optional Activities
Middle Childhood Activities
    Materials
    Involve the Students in the Following Activities
    Possible Optional Activities

EXPANDING THE IDEA PHASE
To the Teacher
Early Childhood Activities
    Materials
    Involve the Students in the Following Activities
    Possible Optional Activities
Middle Childhood Activities
    Materials
    Involve the Students in the Following Activities
    Possible Optional Activities

Final Evaluation

Glossary and/or Concept Map
Figures (for making class transparencies)
Student Handouts (for reproduction)



Natural Resources

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NATURAL HISTORY OF A TREE

HAPPY BIRTHDAY, HOW OLD ARE YOU?

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NATURAL HISTORY OF A TREE

NATURAL HISTORY OF A TREE

HAPPY BIRTHDAY, HOW OLD ARE YOU?

BACKGROUND INFORMATION FOR TEACHERS

This module would be appropriate with science textbook and teacher prepared science units involving growth in plants in general, plant structure, trees and forests, or ecology. These activities allow students to investigate plant growth which occurred over many years as compared to a few weeks growth involved in most plant units. The activities within this module ideally require several days, but are flexible enough to be shortened or extended to fit the teacher's schedule. The teacher is advised to read over the units carefully and plan accordingly.

In the areas with climates which have four seasons, temperate climates, a tree forms a growth ring by adding new wood each year. A tree's age can be determined by counting these rings. We can tell many things about the tree's environmental history from patterns or breaks in its rings. Many questions can be posed from such an examination including: Did the tree receive adequate moisture every year? Were soil nutrients available? Did its neighbor crowd it or shut out its light? Was it ever stripped of its leaves due to insects or burned in a fire?

Dendrochronology is the process of determining a tree's history by examining its growth patterns. Foresters and scientists examine the variations in a tree's growth rings to determine its past. This module provides an introduction to the concepts and methods used in dendrochronology.

Each year, during the growing season, a tree grows a new layer of wood on the outside just under its bark, thereby increasing the diameter of the tree. Each new layer of wood, called an annual ring, identifies each year of the tree's growth. Rings are exposed in a cross section of a tree's trunk. The center part of a tree cross section is generally a darker-colored zone, called the heartwood. The darkening results from deposits of liquids transported over past years between the roots and upper regions of the tree. The heartwood functions now only as a mechanical support for the tree. The light-colored zone surrounding the heartwood is the sapwood. The sapwood performs sap transport and food storage functions. As substances accumulate and block passageways, sapwood transforms into heartwood. The outer part of a tree cross section consists of bark, and between the bark and the sapwood, lies the growth layer, or cambium. New cells are added only in this growth layer at the outside of the tree. The bark provides an expandable, protective layer covering this growth layer.

During the early growth season of each year a layer of large, thin-walled, light-colored cells is formed, called the spring wood. Smaller thick-walled cells form darker summer wood. This summer wood formation occurs when there is plenty of building material available, but a shortage of water. Side by side, the spring wood and summer wood appear as a single annual ring repeated over and over in the inner parts of a tree. In temperate regions where growth is interrupted each year during the dry, cold period of winter, these rings serve to indicate the age of the tree. When growth conditions are favorable and food and water are abundant, such as during the spring, the rings are wide. During drought, the growth slows down and the rings are narrow. In the tropics, where the growing season is 12 months long, the rings are difficult to detect. The absence of a dry season in some areas of the tropics is the major reason for the absence of annual rings.

Once a tree establishes a point on its trunk, or creates a new branch, that spot or branch will never grow further from the ground. For example, once a tree sends out a branch six feet from the ground, that branch will always remain six feet from the ground, no matter how tall the tree may grow. Instead, the tree will add new wood at the end of its branches to increase its height and at its outer layer to increase its diameter.

The following activities are designed to help students conceptualize the more concrete aspects of how growth patterns of trees are reflected in their internal makeup.

OBJECTIVES: Choose those appropriate for your students.

-Practice and improve observing and classifying skills.

-Identify and communicate similarities and differences in the plant world.

-Identify the following in a cross section of wood: injuries, insect damage, annual rings, slow growth, rapid growth, patterns of growth, spring wood, summer wood, heartwood, and sapwood.

-Make inferences about weather patterns and other changes in the environment based on observed patterns in tree cross sections

-Construct graphs, time lines, and illustrations representative of an individual tree's life chronology.

-Compare cross sections showing growth over years within and between different types of trees.

-Describe and demonstrate how changes in the environment might affect the features of trees as seen in a cross section.

EXPLORATION PHASE

TO THE TEACHER:

The initial phase of exploration involves interactive activities using observation and other science process skills to help students, on their own, discover basic concepts and relationships in tree growth. The teacher should use this time to organize groups, observe interactions, and permit students to investigate possibilities themselves. Students should be asking questions, gathering first-hand information, and making connections to their previous experiences in and out of school. Ideally the student should be confronted with a problem or event which cannot be explained by past knowledge.

EARLY CHILDHOOD ACTIVITIES

Materials: for the class
- 1 large cross section of a tree for teacher demonstration
- placemat of paper with lines drawn to help students group the "wooden cookies" (See Figure 1)
- 1 magnifying glass for each group
- 4 - 6 thin cross sections of trees (wooden cookies) or cut out diagrams of cross sections for each group (See Student Handout 1). These cross sections can be made by cutting small 3 - 6 inch (8 - 15 cm) diameter trees or limbs into cross sections about 2 - 4 inches (5 - 10 cm) thick. Thin cross sections will more quickly crack and fall apart over time. Thicker cross sections will allow additional observation of bark and tree surface features.

Involve the students in the following activities:

1. Pass out "wooden cookies" so students can observe and ask them to describe similarities and differences among the "cookies." Use a placemat or plate style work station as shown in Figure 1 to help the students to group/classify the "wooden cookies."

2. Write the following words on the board as they are introduced by the students: trees, wooden cookies, sense words or metaphors describing tree parts, etc.

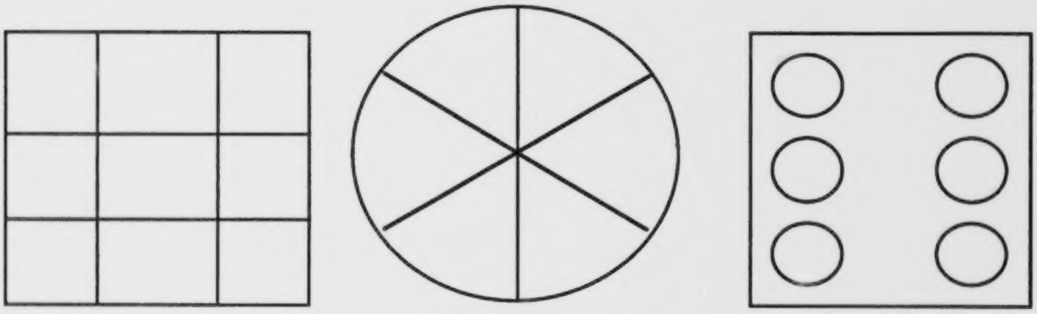


Figure 1
Placemat or Plate Style Work Station

3. Discuss with the students the reasons for their classifications.

4. Pair or group students together.

5. Ask students to think of other ways to group/classify "wooden cookies" - for example, most or least favorite, similar color, size, scent, texture, "floatability", sound qualities, etc.

6. Have each group tell their peers why they put the cookies in specific groups. If possible, have them label each group by writing on their placemats. They may also be asked to tell how they thought the "wooden cookie" became the way it is.

7. Ask the students what senses they used in making their observations of the "wooden cookies." Make sure they have used all senses, except taste, to make observations.

MIDDLE CHILDHOOD ACTIVITIES

TO THE TEACHER:

The following middle childhood exploration requires some structured organization followed by teacher guidance. After a structured beginning, the teacher should become a facilitator and encourage students to explore on their own.

Materials: for each group
- 2 magnifying glasses
- 2 12 inch (30 cm) rulers
- Cross sections of 4 - 5 different tree types
  (Use actual tree cross sections or cut out diagrams in Student Handout 1)
- Tree growth ring chart (Student Handout 2)
- notebook for journal writing

Involve the students in the following activities:

Students will explore concepts of tree growth using cross sections of tree samples. Tree samples can be identified by name or number. Ask them to perform or answer the following:

1. Observe characteristics of cross sections of four to five tree samples, using all senses except taste.

2. Classify the samples using the tree growth ring chart Student Handout 2. If students are using Student Handout 1, be sure to check the name of the sample. This should match the name on Student Handout 2. The cross sections shown on the handout are red oak, red maple, black cherry, white ash, and sumac.

3. Record all observations in a learning log of tree growth rings for the types of trees. This includes expressive writing which elaborates on their sensory responses, their observations and reactions.

4. *Optional: Observe and record characteristics of other types of trees (e.g. walnut, beech, pine, etc.).*

5. What senses did you use in your observations? (They should use all of the senses but taste. Did they make quantitative as well as qualitative observations? Did they make statements that are observations and not inferences, going beyond observable data?)

6a. *Optional: (Note: Students must be provided with actual tree cross sections.) Draw a picture of a cross section of one tree type.*

b. *Compare your picture with the pictures drawn by other students in your group.*

7. What are significant differences you noticed between the cross sections? How are cross sections alike? Could you identify common parts in all of the cross sections?

8. Each cross section shows distinct differences in coloration and size in some way. Can you identify this after reviewing your data?

Note: Instruct students to save journal notes, drawings, and charts in a notebook for future reference.

INVENTING THE IDEA PHASE

TO THE TEACHER:

During this phase of the learning cycle the teacher will play a more directive role. At this time the teacher may wish to refer to notes, background information, etc. The teacher may use inquiry techniques to reinforce exploration activities or simply demonstrate and explain some of the ideas involved in tree growth rings.

Students who were not able to answer the problems or events given in the *Exploration Phase* should be led to an appropriate response at this time.

Concepts to be introduced and related to the students' past experiences in the *Exploration Phase* include:

a) Tree growth rings as seen in tree cross sections (and longitudinal sections),
b) Variation or patterns of growth,
c) Tree structure,
d) Tree environment,
e) Tree history as reflected in growth patterns.

At the end of this module is a diagram showing relationships between these concepts and a glossary defining these concepts.

EARLY CHILDHOOD ACTIVITIES

Materials: for each group
- 3 - 5 “wooden cookies” or tree cross sections from Student Handout 1
- 1 magnifying glass

Involve the students in the following activities:

Begin the early childhood class with a brief story, written or oral. Facilitate interest through discussion and pictures.

1a. *Optional: Read story about lumberjacks, foresters, trees, etc. Choose any which may be readily available in your room or school library.*

Some examples include:
Curra, Ellen. Life in the Forest. Mahwah, NJ: Troll, 1985
Sabin, Fraruru. Wonders of the Forest. Mahwah, NJ: Troll, 1982.
Selsan, Millicent E. & Huis, Joyce. A First Look at Leaves. New York: Scholastic Book Services, 1972
Parker, Bertha Morris. Leaves. Row, Peterson Co., 1959.
Warren, Elizabeth. I Can Read About Trees and Plants. Mahwah, N.J.: Troll, 1975.

b. *With the students help create a word catch on the board, or use a flip chart, listing new words introduced in the module which relate to the main idea of the story. Save the word catch for use as evaluation at the end of the module.*

2. Show pictures of different sizes of trees and ask about the differences seen. Pictures can be used from this module, teacher made drawings, student texts, library books, etc.

3. Discuss birthdays and how it is known when to celebrate birthdays.
   - This should lead to the question, "How do people, animals, and plants show growth over the years?"

4a. Pass out "wooden cookies" for students to handle and comment about.
   - Ask students to describe differences noted in the tree pieces.
   - If not noted, ask the students to count the rings of each piece.
   - Ask them to relate some of these differences to tree age.

b. Recalling Activity 4a, discuss the common tree cross section characteristics - growth rings and what they tell about the tree.

5. Apply knowledge about growth rings to discuss the possible growth history of a tree. Using a cross section of a tree, discuss with the class its characteristics such as size of rings, possible causes for their sizes, the number of rings for the age of

the tree, and/or possible irregularities in rings which may indicate environmental patterns during a tree's lifetime. Use dittos or transparencies made from parts of Student Handouts 3, 4, 5, 6 or 7 as appropriate for your students.

6. Provide a closure to the *Invention Phase* by briefly stating in the students' level of language that trees have identifiable growth patterns. The personal history of a tree, or perhaps of a forest, is reflected in the observed growth patterns. Use the concepts named at the beginning of the *Invention Phase* in the closure discussion.

MIDDLE CHILDHOOD ACTIVITIES

TO THE TEACHER:

With the middle childhood student, the teacher may begin with a film, guest speaker, lecture and/or fact sheet. Choose from the selection of activities below. All may not be necessary.

Materials: for each group

- Figure 2, and Student Handouts 1, 2 and 3.
- 2 metric (millimeter) rulers
- 2 magnifying glasses
- 1 piece of graph paper
- Overhead transparencies of large versions of Figures 2 and 3, and Student Handout 4, page 1. [Teacher should make these in advance.]

Involve the students in some of the following activities:

1. In a discussion have students incorporate their learning logs in summarizing Student Handouts 1 and 2. For example: "Trees grow at varying. . .," "Each circular ring..." Try to exhaustively obtain as many summary statements as the students are able to give.

2. Complete Student Handout 3. Discuss the results.

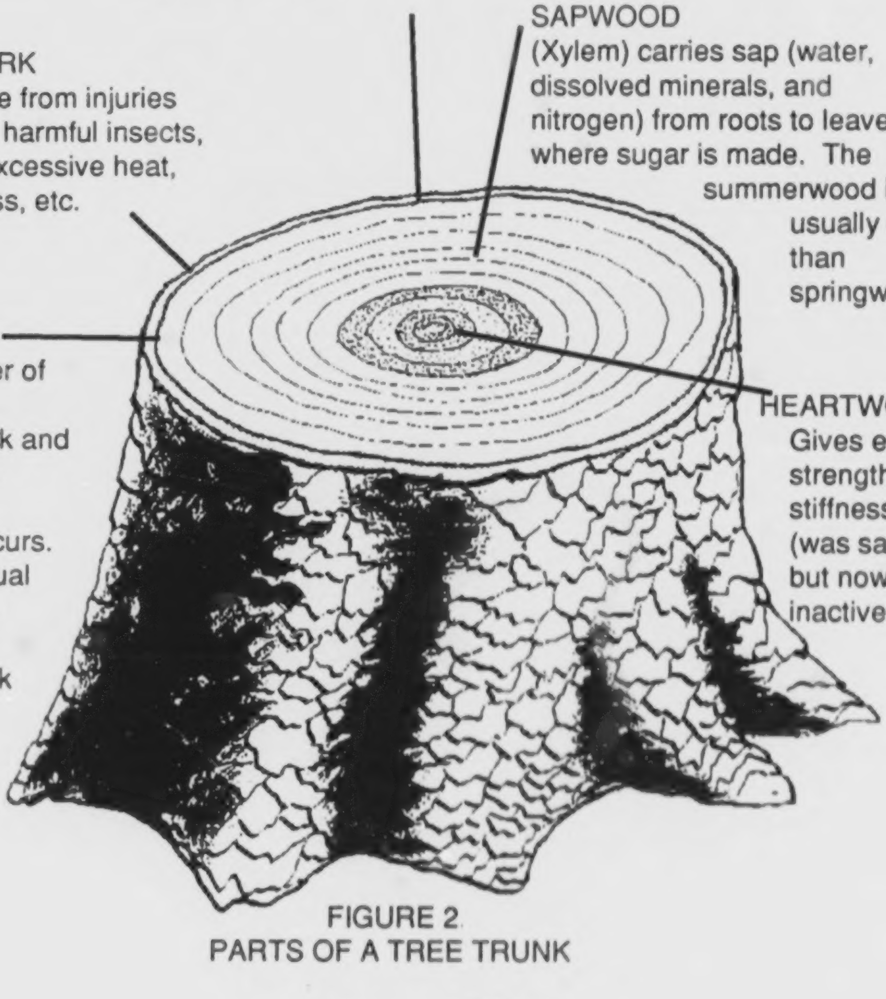
3. Include the following activity to the depth useful for your students: In a class discussion, incorporate the facts below to help students focus on concepts shown in Figure 2. Make a ditto or a transparency. (See large version of Figure 2 at end of module.) The teacher will label parts of the tree cross section to help students develop concepts involved.

TREE RINGS TELL A STORY

When a tree is cut down we can read its life story from rings in its cross section. A light ring for spring and a dark ring for summer show a year's growth. Foresters read this story from a living tree by cutting out a small core (see To The Teacher below).

Trees grow at varying rates. What connection might there be between the rings in the cross sections you observed and growth of the tree in height and diameter?

Each circular ring in the section is called an annual ring. For each growth season two bands are added, a light and a dark band. (see Figure 2). How old is your tree (see Activity 2 above)? Refer students to their work on Student Handouts 1, 2, and 3 if necessary.



INNER BARK
(Phloem) carries sugar made in the leaves down to the branches, trunk and roots, where the sugar is made into other substances vital for growth.

OUTER BARK
Protects tree from injuries by animals, harmful insects, diseases, excessive heat, cold, dryness, etc.

SAPWOOD
(Xylem) carries sap (water, dissolved minerals, and nitrogen) from roots to leaves where sugar is made. The summerwood is usually denser than springwood.

CAMBIUM
A single layer of living cells between bark and wood where growth in diameter occurs. It forms annual rings of new wood inside and new bark outside.

HEARTWOOD
Gives extra strength and stiffness (was sapwood, but now is inactive.

FIGURE 2
PARTS OF A TREE TRUNK

As part of a demonstration identify and describe the following story parts using a large wood sample or overhead transparencies made from drawings in this module (See Student Handouts 4, 5, 6). Point out evidence for each of the following items:

a) The tree starts to grow.
b) Growth slows as other trees shade it from the sunlight.
c) Growth speeds up when surrounding trees are removed.
d) Weather affects growth. Narrow rings show slow growth during dry years.
e) Growth slows as tree begins to reach full size. Nutrients in the soil are reduced.
f) Heartwood, once sapwood, gives trees strength.
g) Sapwood carries sap, water and dissolved minerals, from roots to leaves.
h) Outer bark protects the tree.
i) Inner bark carries sugar made in leaves to branches, trunk, and roots.
j) The cambium layer grows new wood and bark.
h) Sapwood is the youngest and softest wood in the tree trunk. Sapwood will later become heartwood.
k) Heartwood is the oldest and hardest wood in trunk. Heartwood sometimes appears dark in color. It no longer conducts sap.
l) The tree trunk contains "pipe lines" for sap and water.
m) Injuries to trees break the bark and allow insects and disease to enter.
n) Wood rays are lines which cut across tree rings.
o) Tree death.

TO THE TEACHER:

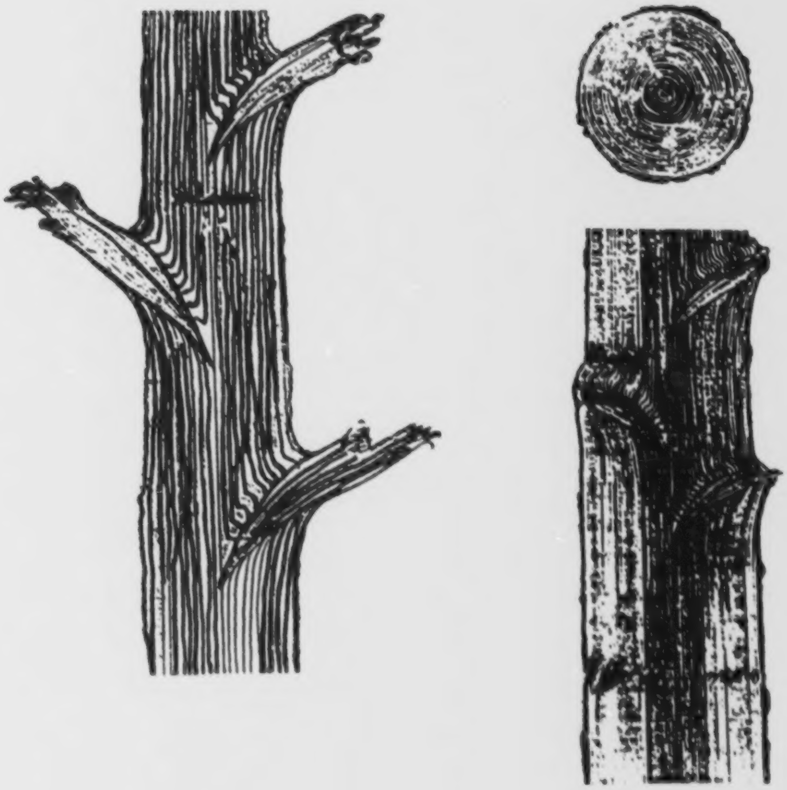
Often a forester wishes to learn the history or age of a standing tree without seriously harming a tree. This is done using an increment borer, a hollow augerlike tool, which is twisted gradually into the trunk. As the leading edge is forced toward the center, it cuts a pencil-thin core of wood which may be removed with an extractor. The rings appear as dark and light bands. If growth characteristics of the outside inch of wood are all that is needed, an increment hammer may be used instead of an increment borer.

4. Have students identify and label as many of the following as possible on Student Handout 4, page 1.

a) Spring wood - the light color part of a complete tree ring.
b) Summer wood - the dark color part of a complete tree ring.
c) Heartwood - the center portion of a tree cross section, sometimes darker in color.
d) Sapwood - the outer portion of a tree cross section.
e) Injuries - some of the deformities seen in the rings.
f) Insect damage - other deformities seen in the rings.
g) Slowest growth - a set of rings closer together than the others.
h) Annual Ring - a repeated set of concentric circles seen in a tree cross section. Usually composed of both a light and dark ring.
i) Most Rapid Growth - a set of rings spaced further apart than the others.
j) Environmental Effect - seen as deformities in the ring patterns.

5. Discuss with the students various characteristics of a longitudinal section of a tree, Figure 3. Make transparency or ditto from the large version of Figure 3 at end of module. Compare to a tree cross section, Figure 2.

Figure 3
Longitudinal Section of a Tree



7. *Optional: Given that every ring with 2 bands, one light and one dark, represents one year of growth, the wider the ring the greater the growth of the tree for the year. Ask students to graph the width of each ring across a tree cross section to discover in which years the tree experienced more growth. Use one of the tree cross sections used earlier, wood samples, or diagrams.*

   Provide students with a millimeter ruler. Ask them to measure each growth ring starting at the center of the tree cross section. Have them record the measurement for each ring on a table. Ask them to graph this data.

   A sample data set has been graphed below. Students should measure enough rings to show some differences in an established pattern.

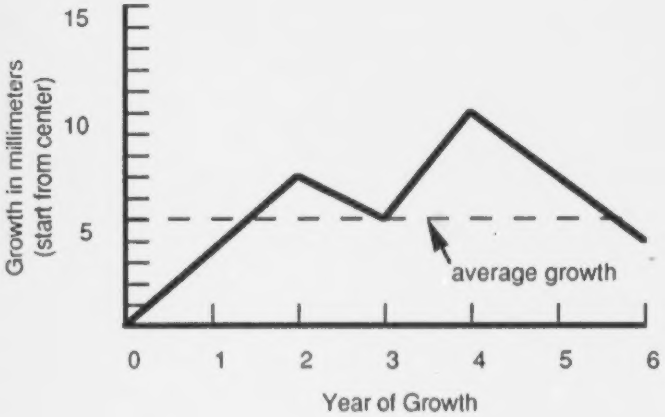


Figure 4
Sample Chart

Students should make inferences about conditions for growth: rainfall, severe weather patterns (drought), mechanical injury, or other disruption. This should occur in a discussion guided by the teacher. The teacher may wish to graph growth in a demonstration on a transparency. Look at the peaks, the greatest growth points. Why did these leaps in growth occur? To view patterns you might have students find the average year's growth. Plot this as a horizontal line. Compare yearly growth to this line to observe patterns.

8. Provide a closure to the *Invention Phase* by briefly defining the tree growth pattern concepts and briefly illustrating them with the experiences above.

EXPANDING THE IDEA PHASE

In the final learning cycle phase the student must use and apply facts, concepts and relationships concerning tree growth rings. Students should refer to the cumulative information written in their journals, fact sheets, etc. New contexts and different ways of looking at the ideas explained in the earlier part of the lesson should now be attempted. Following the *Expanding The Idea Phase*, the teacher should check student outcomes with a quiz, performance test and/or discussion.

EARLY CHILDHOOD ACTIVITIES

TO THE TEACHER:

The students will be asked to create their own tree cross section using art materials and tell a story (fiction) of how the tree got that way.

Materials: for the class

- Various colors of clay, colored markers and yarn. Pastel or earth colors may be used such as brown, yellow, black, gray, orange, pinks, reds. Roll thin strips of clay from each color and cut in sections. This can be performed by students before this lesson or during this activity.

Involve the students in the following activities:

1. Ask students to create a tree cross section by rolling yarn or clay in rings, alternating colors and width for each year's growth. Colored drawings may substitute.

2. Students should illustrate in their model various events in the tree's life, for example:
    a) strong growth or age - thickness and ring number,
    b) injuries, damage or
    c) other events.

3. After completing the tree cross section, ask students to tell a story, or write or dictate a short narrative describing the life of their tree. They could also write a letter to a friend, a brief story, song, poem, or cartoon strip with ballooning conversation items.

4. *Optional: Students could write "wish" poems: "I wish I were a tree, because...," "If I were a tree I would look or be like...because...," "If I were a tree I would feel like..."*

MIDDLE CHILDHOOD ACTIVITIES

Materials: for each group
- Student Handouts 5, 6 and 7
- magnifying glass

TO THE TEACHER:
Students should follow teacher directions and refer to Student Handouts 5 and 6.

Involve the students in the following activities:

1. Ask students to complete Student Handouts 5 and/or 6. They should be able to describe the environmental factors influencing the growth of each tree.

2. *Optional: Students may draw and color a tree cross section of their own design and describe yearly events that may have occurred during growth. Many environmental factors may have impacted growth and tree structure. If the students have difficulty initiating this activity, the teacher may wish to "draw" a 10-year cross section on a transparency, describing the whys of this pattern. The students' description could involve a short story, imaginary logs, letters, newspaper articles, an imaginary passage in a science book, scripts for a radio or television program, scripts for a "Mr. Wizard" show, etc.*

3. *Optional: Students may use the cross sections of the different types of trees in Student Handout 1 for additional practice. They may review data, count rings, graph growth and inter-growth factors, or work on individual projects of special interest concerning tree growth.*

4. *Optional: A social studies / science activity. Ask students to label a tree cross section using a U.S. history reference to describe the events occurring in the United States at that time. Students should write the year associated with each arrow and describe a major historical event which occurred near that date. See Student Handout 7.*

5. *Optional: Students could clip newspaper articles, interview foresters, parents or other people, construct bulletin board displays, make posters, give oral reports, and/or create a pamphlet on what they learned in the module. Parents could be invited to a display of their products in a learning fair held in the class or for other classes of the school, or at a science fair.*

6. As a summary exercise the class may wish to invite an "expert" for a question and answer session to discuss questions that arose during this learning cycle. The teacher may wish to summarize or culminate the unit with student presentations or an on-site field trip to a experimental forestry station or wooded area.

FINAL EVALUATION

The teacher may incorporate work and products not used in the lesson from the *Expanding The Idea* stage for the final evaluation. Students may wish to form panels to discuss growth and conditions for a tree cross section. Finally a teacher may wish to utilize a written format of his/her own design covering material discussed during the module.

GLOSSARY

Tree growth ring - one light and one dark band represents one year of growth.

Variation or patterns of growth - changes in ring width of trees are caused by tree type or environmental conditions.

Tree Structure - heartwood, sapwood, inner bark, outer bark, summer wood and spring wood.

Tree environment - weather or local conditions such as crowding by other trees, thin soil, slope of the land, etc.

Tree history as reflected in growth patterns - the structure of a tree is reflected in its growth patterns. The environment and tree type determines the growth patterns seen in a tree's cross section.

Figure 2

Parts of a Tree Trunk

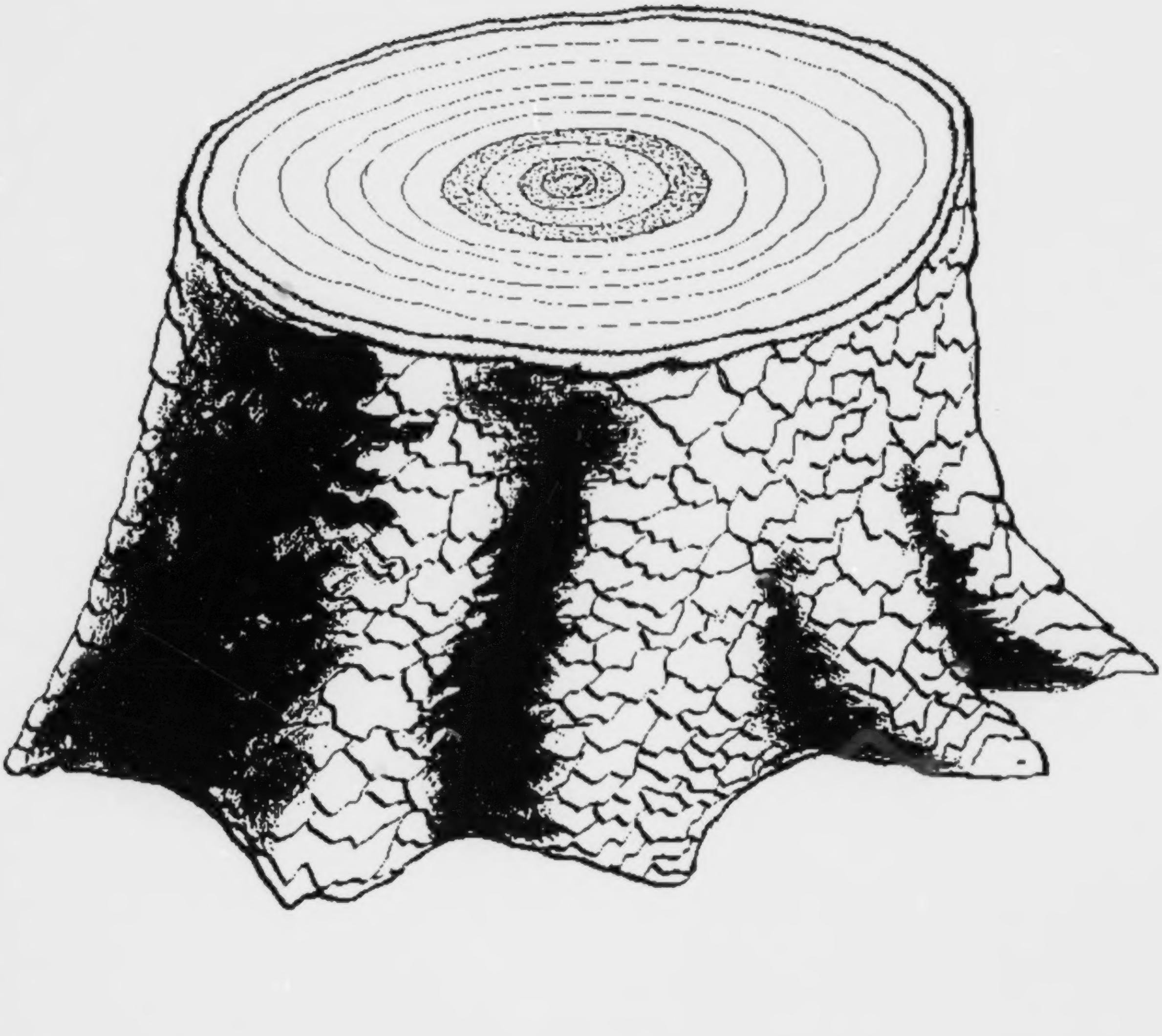
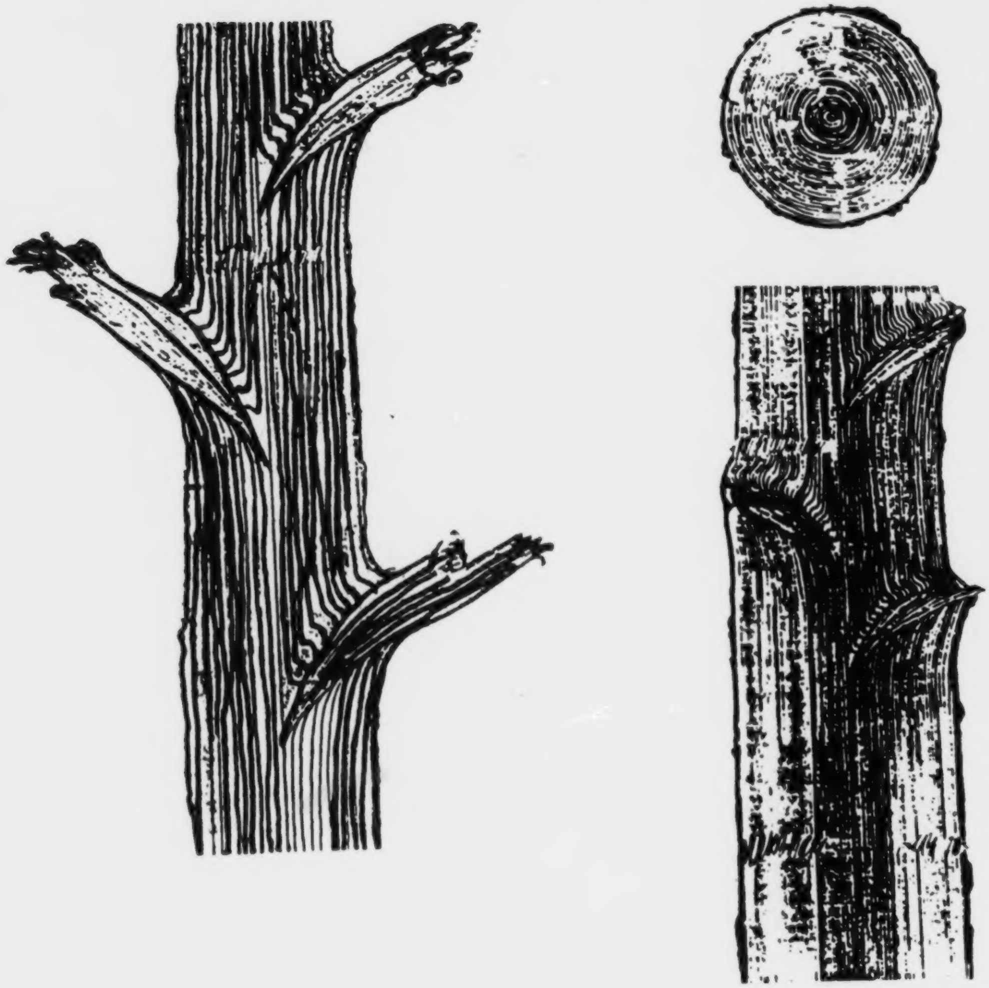


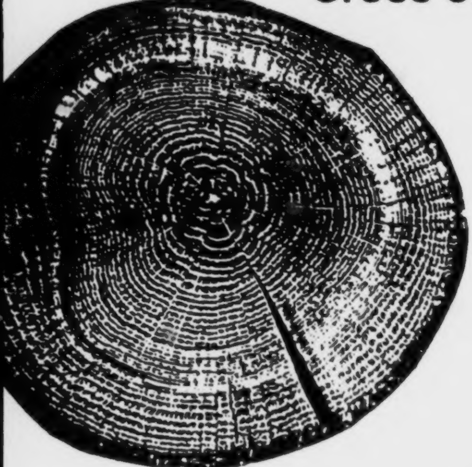
Figure 3

Longitudinal Section of a Tree

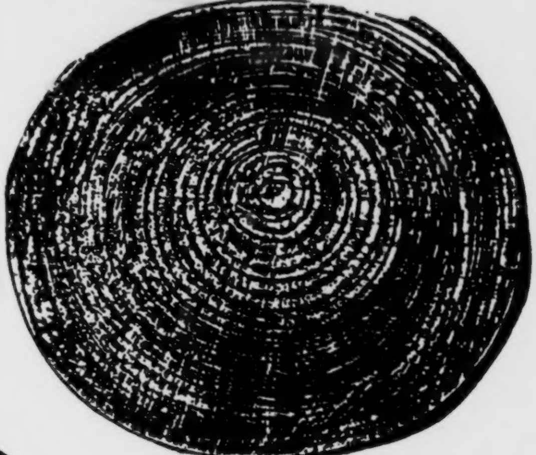


Student Handout #1

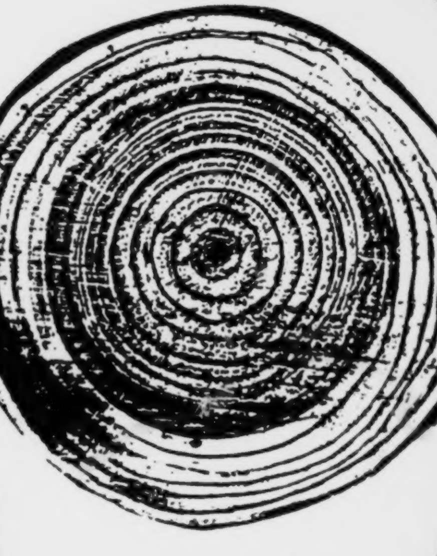
Cross sections of 5 different tree types



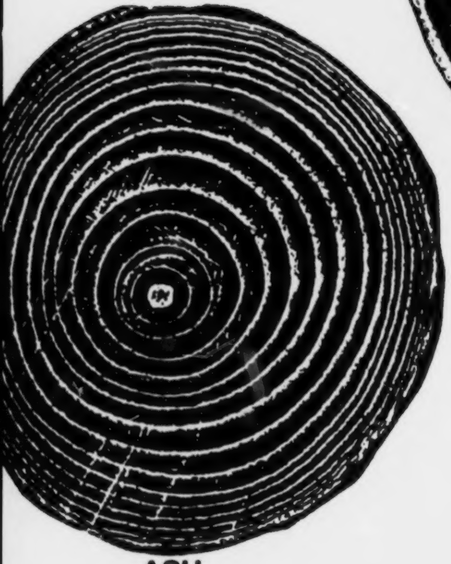
OAK



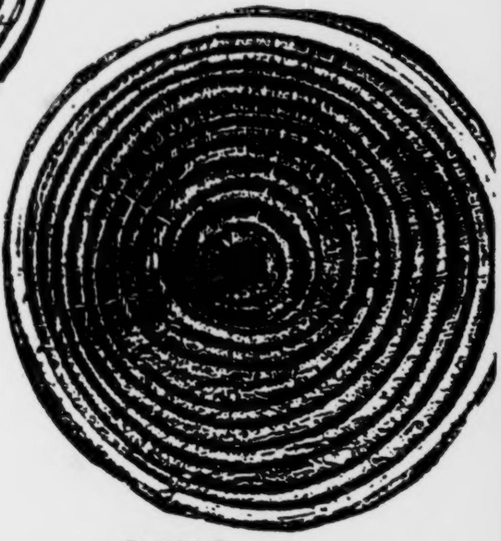
MAPLE



CHERRY



ASH



SUMAC

STUDENT HANDOUT 2

Tree Growth Ring Chart

COLOR

TEXTURE

SOUND MADE

SCENT

ODD MARKINGS

NUMBER OF DARK RINGS

NUMBER OF LIGHT RINGS

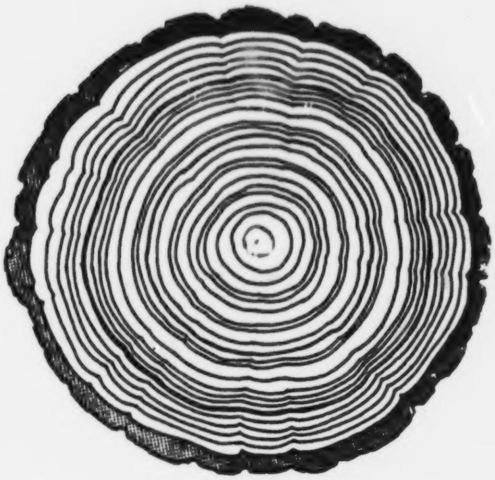
DESCRIBE BARK

PATTERNS

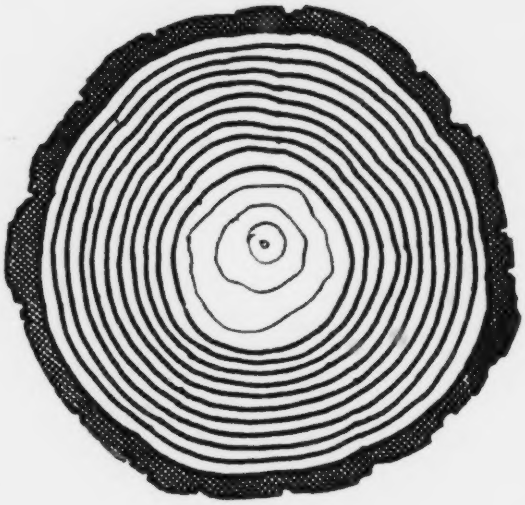
TREE TYPE

STUDENT HANDOUT 3

Comparing Trees



A.



B.

ACTIVITY

1. Compare drawings A and B. Which is older?
2. Which tree had more variation in environment (weather or competition from other trees) as it grew?
3. Use a metric ruler to measure the width in millimeters. of A. Then measure B.

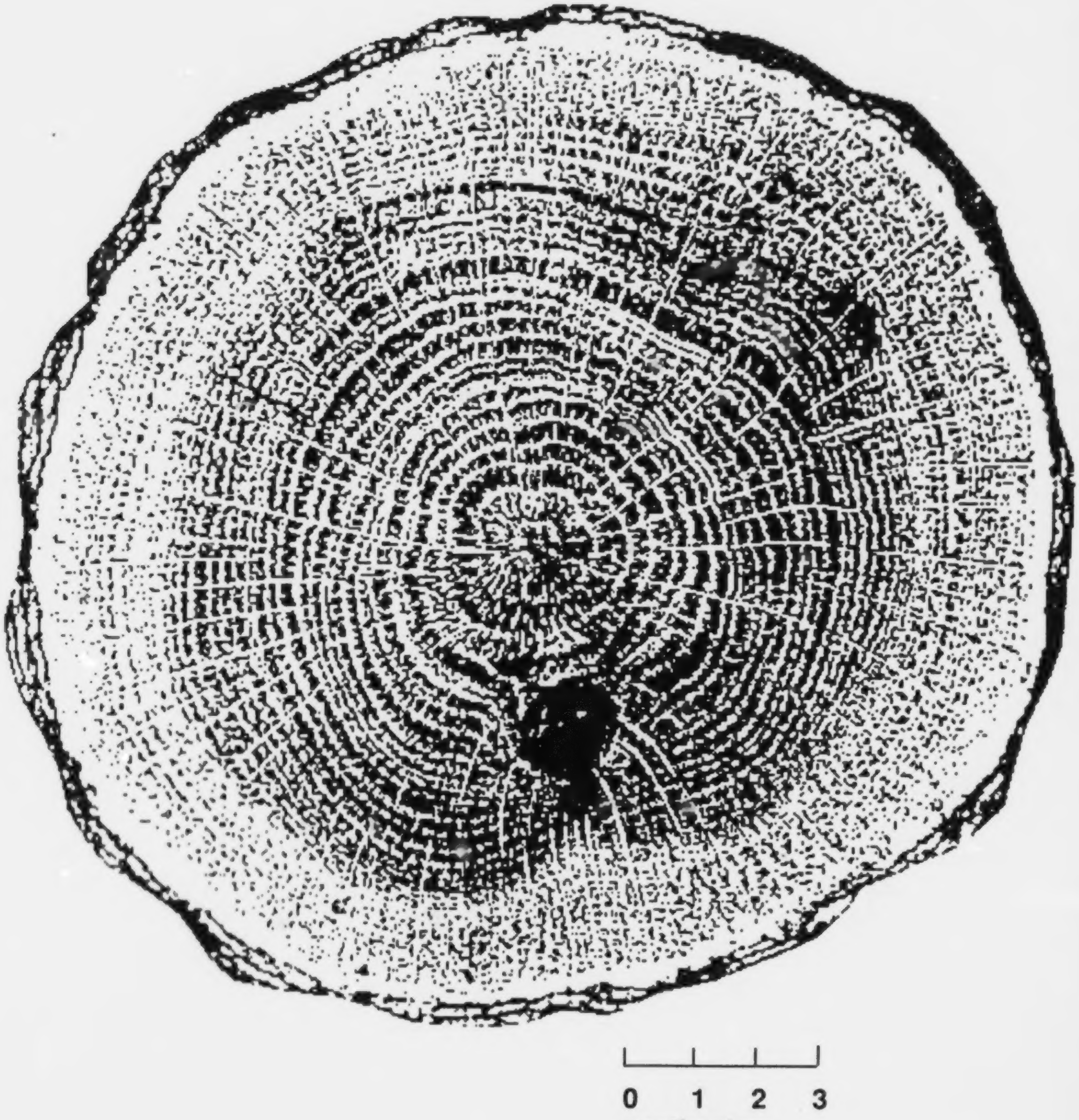
   A = ____________________ B = ________________________

4. Are older trees always wider? What evidence would support your answer?
5. Do you think tree A is taller than tree B? Why?
6. Could tree A be shorter? How?
7. Draw your own tree - How old is it?
8. What has happened to your tree in question 7? Describe your tree's life history as shown by the rings you have drawn.

STUDENT HANDOUT 4

(page 1)

Tree Rings Tell a Story


0
1
2
3
centimeters

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STUDENT HANDOUT 4
(page 2)

Tree Rings tell a Story

Identify and label as many of the following as possible on Student Handout 4, page 1.

a) Spring wood
b) Summer wood
c) Heartwood
d) Sapwood
e) Injuries
f) Insect damage
g) Slowest growth
h) Annual Ring
i) Most Rapid Growth
j) Environmental Effect

Write your own definitions of the following:

a) Spring wood

b) Summer wood

c) Heartwood

d) Sapwood

e) Injuries

f) Insect damage

g) Slowest growth

h) Annual Ring

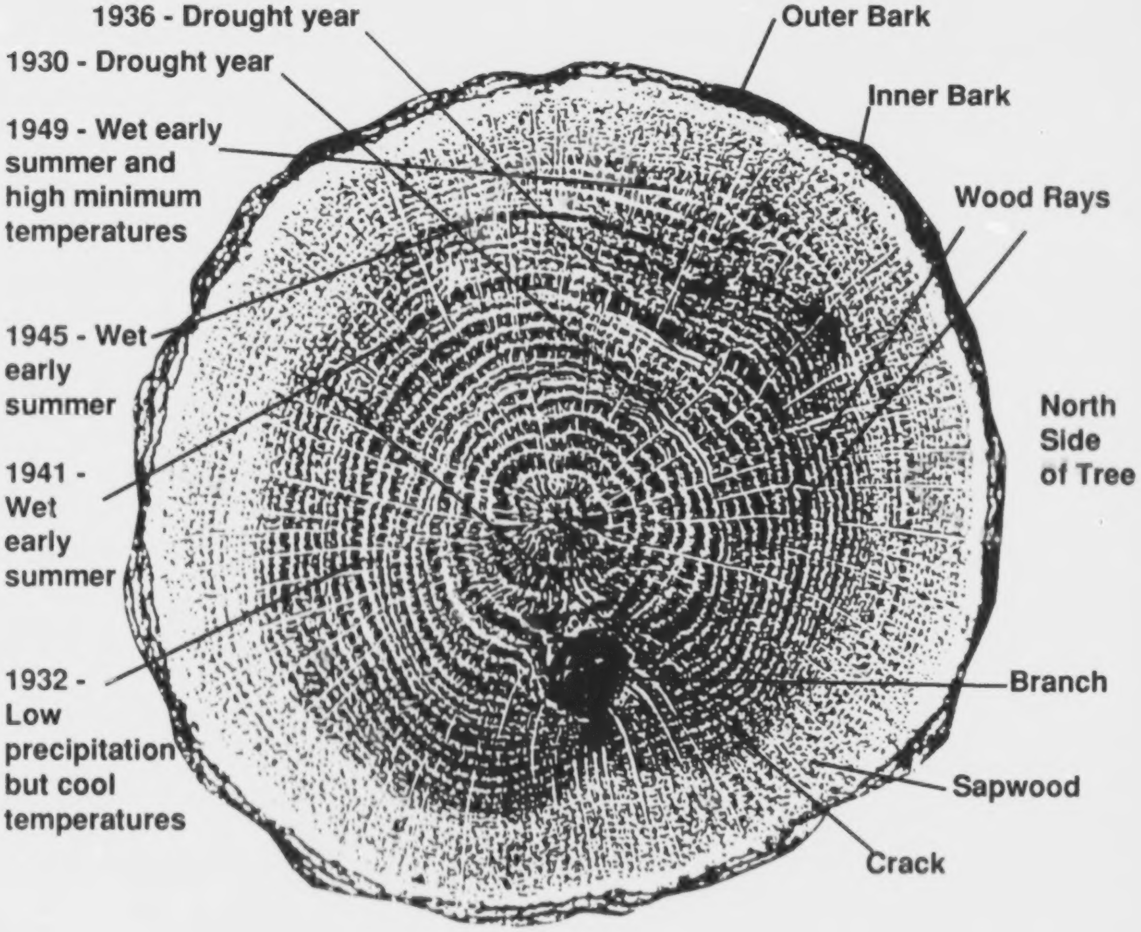
i) Most Rapid Growth

j) Environmental Effect

STUDENT HANDOUT 4

(Page 3)

Tree Rings Tell a Story - Teacher's Guide
Cross Section of Chestnut Oak Tree


1936 - Drought year
1930 - Drought year
1949 - Wet early summer and high minimum temperatures
1945 - Wet early summer
1941 - Wet early summer
1932 - Low precipitation but cool temperatures
Outer Bark
Inner Bark
Wood Rays
North Side of Tree
Branch
Sapwood
Crack

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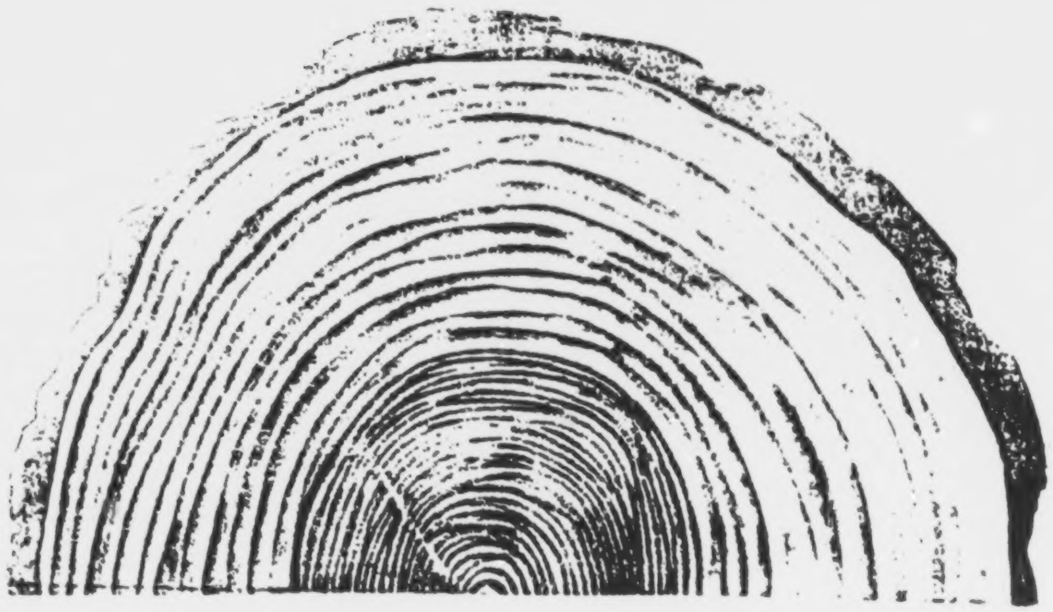
STUDENT HANDOUT 5

Cross Section of a Tree



Look at this cross section:

1. During the course of this tree's growth describe the changes in the growth ring patterns.
2. When did this happen? (How old was the tree?)
3. How long did the tree live after this event?
4. Why did this happen? Make up an event.
5. If the change had not taken place, how might the tree look? Would the tree diameter be larger, the same or smaller?

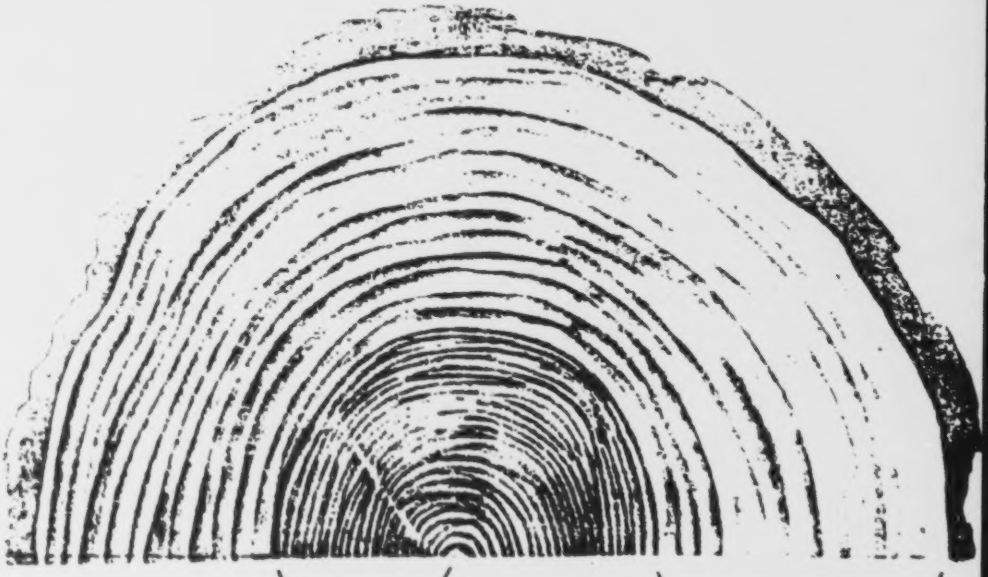
STUDENT HANDOUT 5

(page 2)

Cross Section of a Tree - Teacher's Guide

THINNING INCREASES GROWTH

Annual rings show age of tree.

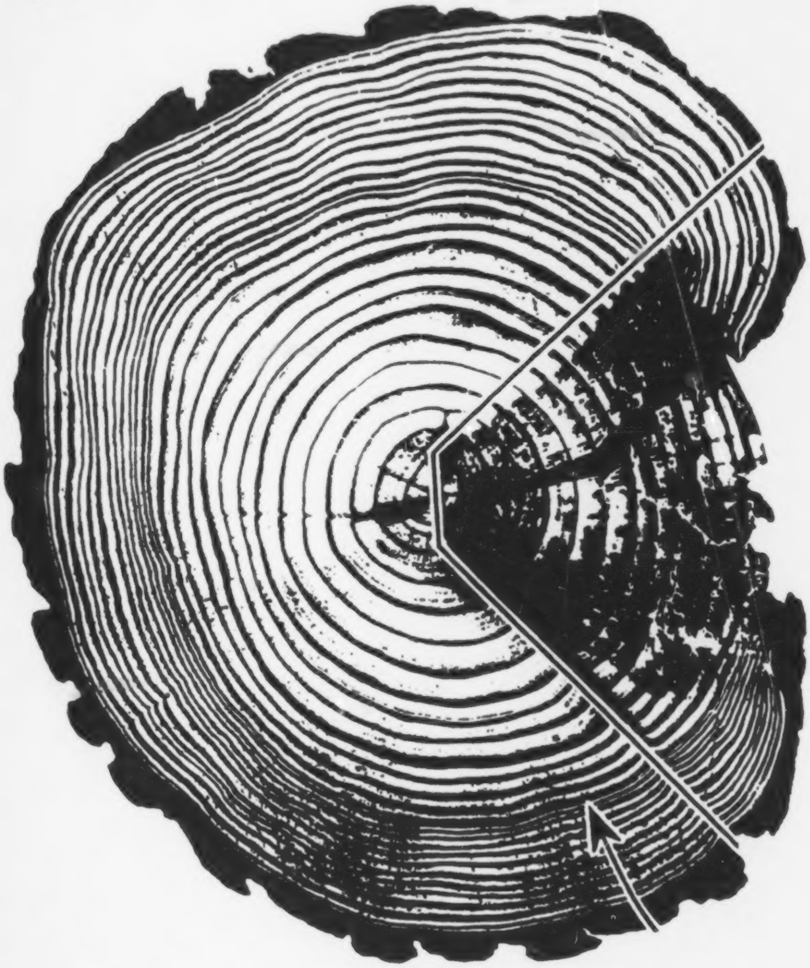


35 years' growth before thinning

16 years' growth after thinning

STUDENT HANDOUT 6

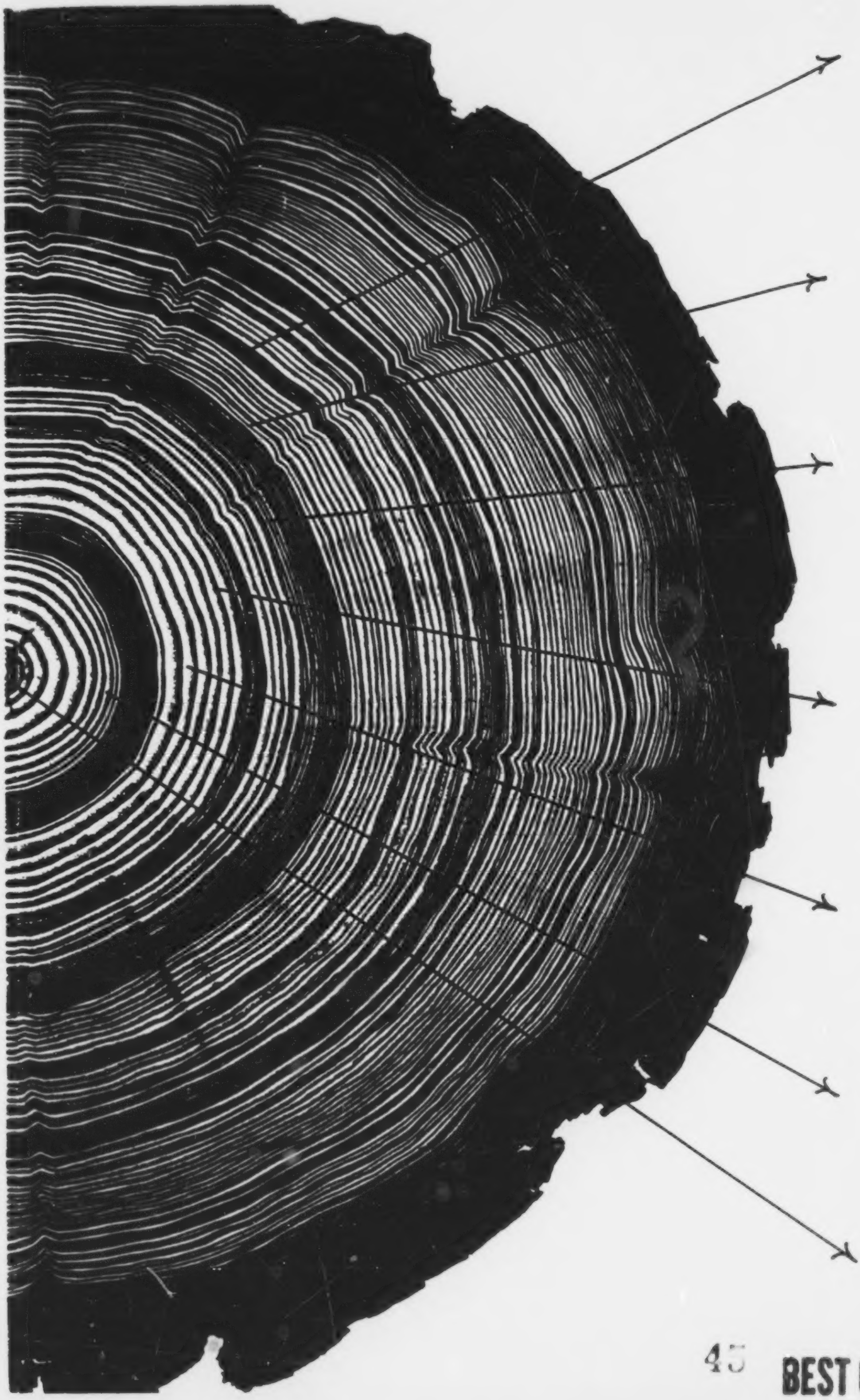
What Happened Here?



1. How do you account for the blemish? What happened to the tree?
2. How old was the tree when this happened?
3. How was the tree further injured after the first injury?
4. Would this affect growth?
5. After the tree was older the rings are closer together--what do you think caused this?
6. What does the location of the arrow indicate?

STUDENT HANDOUT 7

America's History is Written in Her Trees



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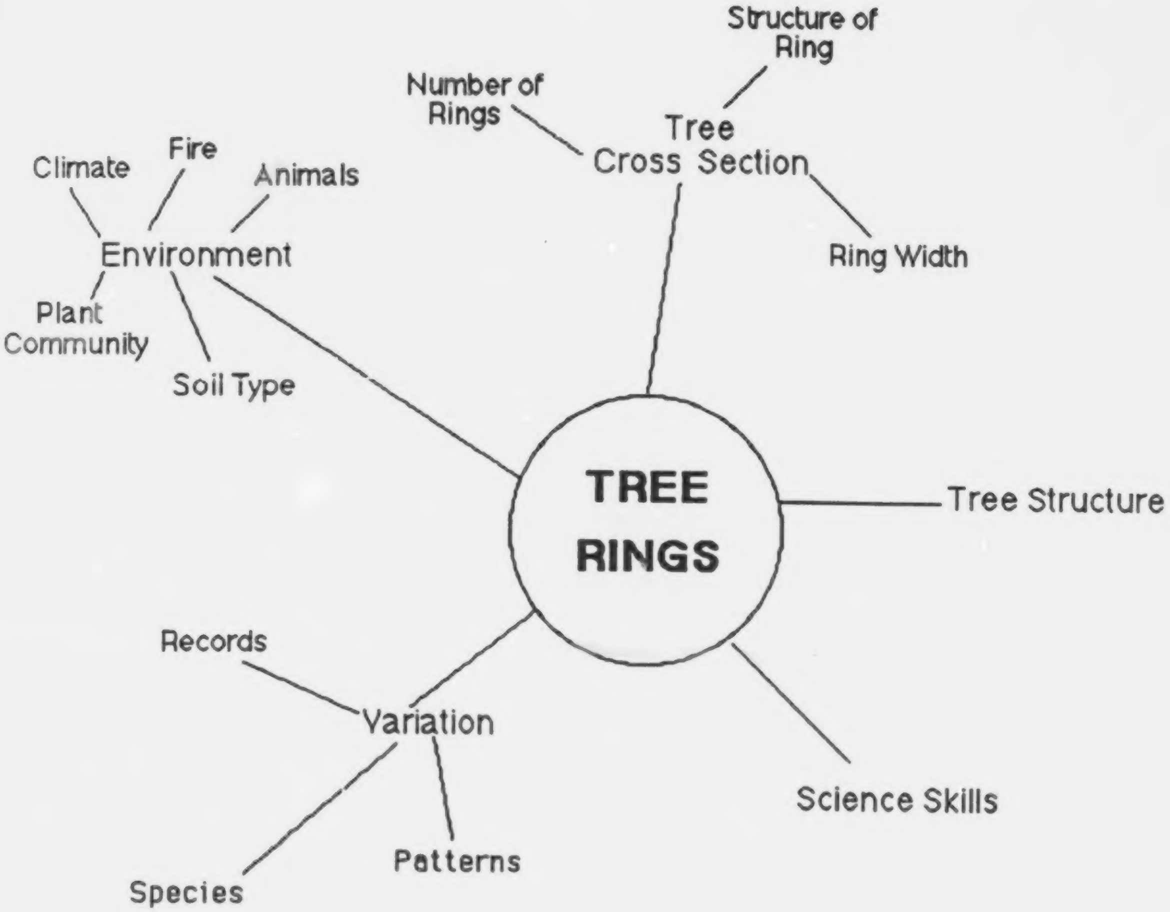
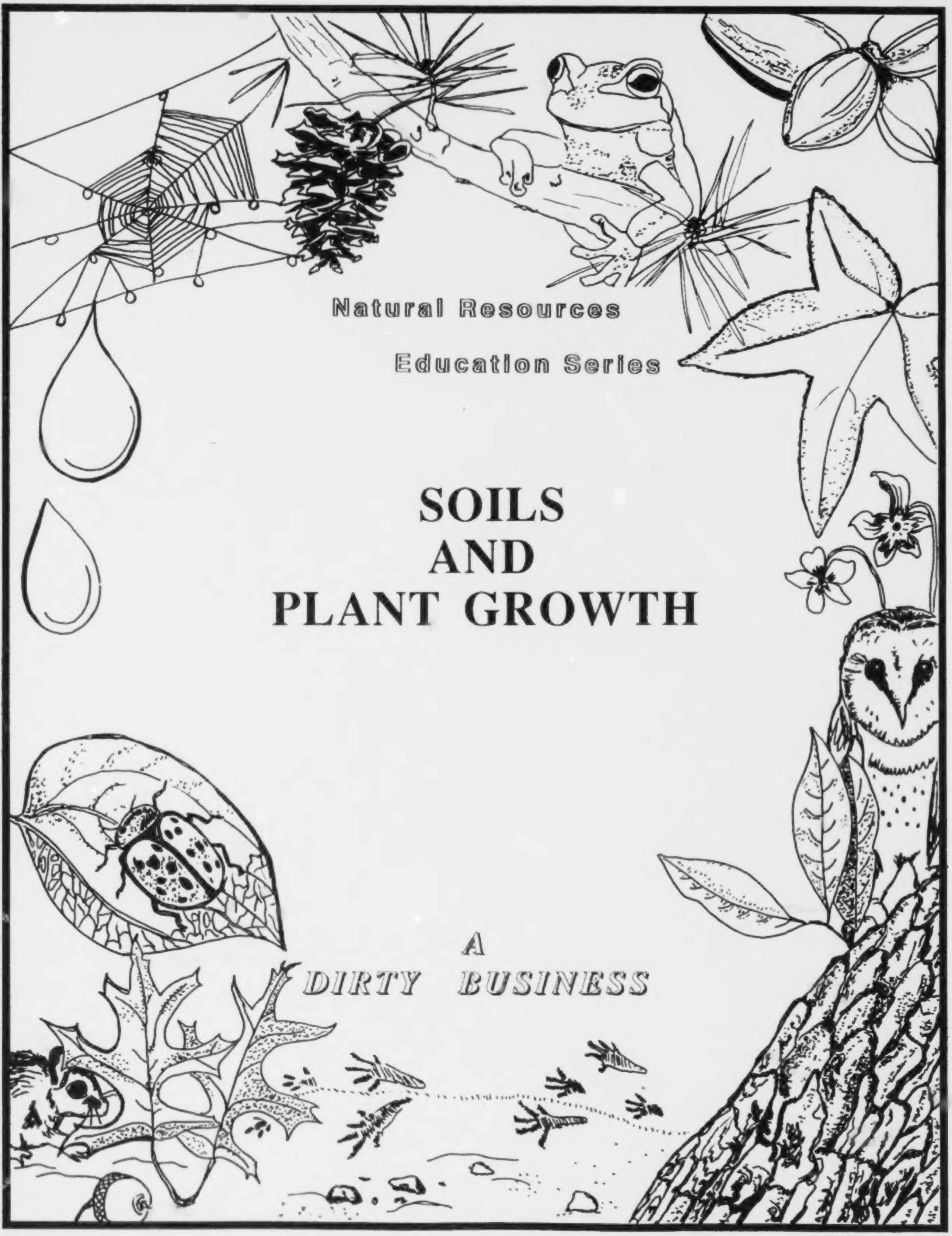
TREE GROWTH RINGS AND WHAT WHAT THEY TELL US


Structure of Ring
Number of Rings
Tree Cross Section
Ring Width
Climate
Fire
Animals
Environment
Plant Community
Soil Type
TREE RINGS
Tree Structure
Records
Variation
Species
Patterns
Science Skills



Natural Resources

Education Series

SOILS
AND
PLANT GROWTH

A
DIRTY BUSINESS

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The writing, development and, production of the *NATURAL RESOURCES EDUCATION SERIES* is a joint project with collaboration of project directors Dennis W. Sunal, The University of Alabama, and Mary E. Haas, West Virginia University, and the U.S. Forest Service. Partial funding was provided by the U.S.D.A. Forest Service. The initial author and series editor was Dennis W. Sunal. Revision of individual modules was carried out with the help of Mary E. Haas, and Cynthia S. Sunal. Assistance in creating appropriate activities, proof reading, and creating art work by computer for the many editions was provided by Jon Berninzoni, Elwin Dickerson, Tracy Johnson, Jane McGinnis, and Sukhwindar Singh. Final editing assistance on the text and artwork was performed by Audrey Rule. William Kline, Jr. assisted in training the original trial teachers. Content reviewers were specialists in the various module topics at the U.S. Forest Service including Monongahela National Forest staff members, Theresa Anne, Randolph Harrison, Linton Wright, and Harry Mohoney, and Northeastern Forest Experiment Station, Timber and Watershed Laboratory staff Pamela Edwards, David Helvey, James Kochendorfer, and Clay Smith. Teachers in the Randolph County, West Virginia Schools who first taught the modules and made recommendations for revisions were: Sandra Arbogast, Sara Basil, Ann Deloach, Karen Hall, Richard Leitner, Elizabeth McDonald, Linda Moore, Sharon Moss, Pam Mullennex, Jeff Ranhart, Theresa Skidmore, Rachel Snavely, Charles Swecker, Nancy Taylor, Angela Vance and Rebecca Wallace.

The *NATURAL RESOURCES EDUCATION SERIES* is designed to supplement textbooks with active learning lessons for students in the primary and middle childhood grades (K-8). The series consists of Understanding Our natural Resources Teacher's Guide and 12 Modules including Appreciation of Natural Beauty, Soils and Plant Growth, The Water Cycle, Natural History of a Tree, Recipe for Tree Growth, Tree Growth and Environment, Forest Processes, Managing Our Forest Resources, Growth of a Forest, Interactions of Forest Plants and Animals, Natural Watersheds, and Managing Our Natural Resources.

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SOILS AND PLANT GROWTH

SOILS AND PLANT GROWTH

A Dirty Business

BACKGROUND INFORMATION FOR TEACHERS

This module would be appropriate with teacher prepared units and existing textbook chapters on weather, soils and erosion, and plant growth. The activities within this module require preparation and planning. Different soil types, rocks and pre-germinated seeds (beans) with initial growth of 3 - 5 days are needed before you begin teaching. The activities ideally require several days to complete, but are flexible enough to be shortened or extended to fit the teacher's schedule. The teacher is advised to read over the units carefully and plan accordingly.

Soil. Earth. Mud. The ground. No matter what it is called, it's the material that constitutes the outermost solid layer of the Earth. People build on this layer, raises food in it, and mines mineral resources from beneath it.

Soil exists as a naturally occurring mixture of minerals (inorganic substances with definite physical and chemical properties) and organic matter (plant and animal material in various stages of decomposition), water, and air. The exact composition of soil varies from one location to the next. However, an average composition by volume of the major soil ingredients are;

Table 1
Soil Composition

45%	Minerals (clay, silt, sand, gravel, stones),
25%	Water (the amount varies depending upon precipitation and the water holding capacity of the soil - see glossary),
25%	Air (essential for living organisms within the soil) and
5%	Organic matter (both living and dead organisms).

The minerals that form a soil are products of weathered parent material. With the exception of stones, gravel and other rock debris, most of the mineral particles in soil can be classified as sand, silt, or clay. Particles of sand, which range in diameter from 2 millimeters to 0.05 millimeters, are easily seen with the naked eye, and have a gritty feel. One millimeter (mm) is about the thickness of a dime. Silt particles are found in sizes from 0.05 mm down to 0.002 mm and feel like flour. Clay particles are smaller than 0.002 mm and cannot be seen with the naked eye. Clay particles are the most reactive mineral ingredient in the soil. Moist clay usually feels sticky. Loam is a mixture of clay, sand, and silt.

Water and air occupy the areas between the mineral particles within the soil, which are called the "pore spaces." In these small spaces, water and air are available for plants to use. These small pore spaces are necessary for the growth of soil organisms and plants. As a result, the amount of pour space is related to soil productivity.

The final ingredient in soil is organic matter. This is comprised of dead plant and animal material as well as the billions of living organisms found in the soil. Very often, this organic matter is referred to as humus.

There are strong interactions between plants, animals and soil. Soil lends physical support to plants and provides them with nutrients, dissolved minerals and water. Plants with roots obtain nutrients and moisture from soil through their roots. Plant organic matter returns to the soil to be decomposed by organisms within the soil. This decomposition process further releases nitrogen and other elements for re-use. Thus plants affect the soil by adding organic matter which has an important influence on the soil's physical and chemical properties, and further serves as a source of energy and nutrients for the soil plants and animals. Penetration of the soil body by plant roots affects the aeration and water movement through the soil. The vegetative cover protects the soil from the direct impact of sunlight, wind, and rainfall, and modifies climate extremes, especially during the warm season.

Although plants are the most visible large organisms, many animals also inhabit soils. Earthworms are the most easily recognized of this group. It has been estimated that between 200 and 1000 pounds (91 and 455 kilos) of earthworms can be found in one acre (4,047 square meters) of soil. Earthworms eat organic matter and other soil particles that get mixed in. They digest organic matter and pass nutrient-enriched soil through their bodies. This recycles nutrients and makes soil richer. In addition, the tunnels of earthworms allow air and water to penetrate the soil more rapidly.

Soil moisture is the most important factor which can limit the growth of plants. Soil moisture is related to the capacity of a soil to retain water and to soil texture. Clay-like soils feel very smooth and sticky. Sandy soils feel very gritty. Loamy soils fall between these two extremes: they are smooth, slick, and partially gritty and sticky. Clay-like soils are usually dense but can hold a great deal of water. However, the water is held so tightly that it is less available for plants. Thus, a heavy clay holds too much water and keeps oxygen out of the root areas, so there is insufficient aeration within the soil. Loamy soils are loose and crumbly and are well aerated. They hold water quite well for use by plants. Sandy soils are loose and crumbly, but they are so porous that little water is held for plants to use.

The roots of plants absorb nutrients and water primarily through tiny projections called root hairs. Soil water places root hairs in chemical contact with nutrients on the surface of clay and humus particles (i.e. Hydrogen ions provided by carbonic acid clinging to the root hairs are exchanged with chemical nutrients such as magnesium, calcium, and potassium in a process termed nutrient exchange).

In summary, water can limit growth when its quantity is both insufficient or excessive in the soil. When an excess amount of water is present in the soil, oxygen is not able to reach the tree roots, resulting in anaerobic (without oxygen) conditions, and prohibiting root respiration. When water is insufficiently available, plants may not carry out photosynthesis. Consequently, too much or too little water leads to problems in plant growth.

SOIL FORMATION:

There are hundreds of different soils found throughout the world. There are five important soil forming factors which need to be considered.

1. The first important factor is parent material. Parent materials are materials, both mineral and organic, from which soil is formed. Parent material can be a volcanic deposit such as ash, it can be a sediment that has been transported and deposited by wind or water, or it can be a deposit left by glaciers. Weathered bedrock can also be a parent material. Moderately developed and well-developed soils are made when a parent material is changed both chemically and physically over time.

2. Climate also affects the formation of soils. Parent material is broken down into finer particles through weathering, which is controlled by the climate of a given location. Temperature and weather are the major climactic conditions that influence weathering Frequent freezing and thawing will cause water trapped in cracks to expand, exerting pressures which fracture rocks and smaller materials even further. Alternate wetting and drying also breaks down particles because not all minerals expand and contract at the same rate. Water also tends to dissolve certain minerals from parent materials.

3. Living organisms can also help to create a soil. As plants and animals die, they add organic matter to weathered parent material to help form subsoil and topsoil. As animals dig through the soil, they break it up, permitting more air and water to enter. They mix up the organic matter throughout the soil. Smaller plants and animals such as bacteria and fungi also enrich the soil by breaking down organic matter into simpler nutrients. Thus, it is apparent that the actions of plants and animals help form topsoil on moderately developed and well developed soils.

4. Topography is another factor that influences soil formation. Topography can be described as the hilliness, flatness, or amount of slope of the land. Soils vary with topography due to the influence of moisture and erosion. In many areas, moist, poorly drained soils are located in low areas and depressions of the land. In contrast, soils in sloping areas can be drier and well drained. These soils tend to be moderately or well developed. Erosion can remove all or part of the topsoil and subsoil, leaving behind a poorly developed soil.

5. Finally, the age of a soil is considered in thousands (and even millions) of years. It may take hundreds of years for these factors to form one inch of soil from parent material. The older the soil, the more time these factors have to affect soil properties.

OBJECTIVES: Choose those appropriate for your students.

-Practice observation and classification skills.

-Identify and define the major components in soil.

-Examine and compare the characteristics of the different kinds of soil found in the local community.

-Describe how and why soils differ.

-Identify and describe a soil profile (horizon).

-Identify and compare the effects different soils have on forest types and various plant species.

-Identify and compare the affects different plant communities have on soils and soil profiles.

-Explain the processes by which parent material, climate, living organisms, topography, and time are related to soil formation.

EXPLORATION PHASE

TO THE TEACHER:

The initial phase of exploration involves interactive activities using observation and other science process skills to help students, on their own, to discover basic concepts and relationships in soils of the forest. The teacher should use this time to organize groups, observe interactions and permit students to investigate possibilities themselves. Students should be asking questions, gathering first hand information and making connections to their previous experience in and out of school. Ideally the student should be confronted with a problem or event which cannot be explained by past knowledge.

EARLY CHILDHOOD ACTIVITIES

Materials: for the class
You'll need about 1 gallon (4 liters) each of:
- sand soil
- clay soil
- rocky soil

Other materials:
- 7 or more empty paper/plastic milk or soft drink containers with tops cut off
- 20-30 clear plastic containers or coffee cups to hold soils (4 containers per group)
- small shovels, one for each group
- labels for the plastic containers, at least one per container

- felt pens, one per group
- student recording sheets (if needed), Student Handout 1
- magnifying glasses, one for each student

Involve the students in the following activities:

1. After a recess period outside or before snack time or lunch have students wash their hands. While they are washing hands ask informally and individually, "What is that you are washing off your hands?" You should expect their reply to be "dirt". Continue questioning: "Where did it come from? Is it good for something?" Students' answers will vary but in general their replies will be that dirt comes from the ground and that it is good for nothing.

2. After the students are seated in the classroom show them a potted plant or tree seedling. Ask the students to describe or demonstrate (model) how a plant grows. Comments about seeds, sun, rain, dirt, soil or ground can be expected.

   Ask: 1) Where must seeds be so that they may grow?
   (You may want to remind the class that they said "dirt is good for nothing.")

   2) How do the seeds in the forest get into the ground?

3. Take students outside and point out where trees may produce seeds and how they may get to and into the ground.

   Ask: 1) Why is dirt good for seeds and the forest?

   2) What is it about dirt that makes it valuable to the forest?
   (Record their answers so that you can use them as a way to evaluate learning.)

   3) Tell the class that a word for the material that plants and trees grow in is soil.

4. Take class outside on a short field trip to collect soil from two to three different areas around the school. Try to find locations where soil types may differ (eg. near the school clay may be prominent due to school construction, near a stand of trees soil may be loamy because of tree debris). The students can use 1/2 gallon (two liter) milk containers for gathering soil. See Figure 1. Ask the class to describe the soils collected in their own way. Then give them some criteria for classifying soils such as: wetness, dryness, stickiness, amount of decaying material, ease of collecting (was the soil easy to dig or not), amount of rocks or stones, numbers of insects and/or worms.

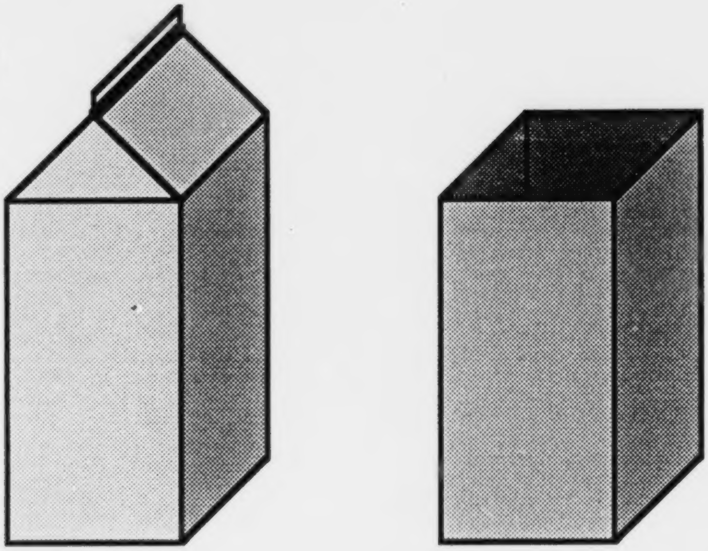


Figure 1
Container Construction

Back in the classroom after the students have described their soils, lead them to conclude that there are different soils. Ask the students whether some soil would be better for some plants than other soil. Show the class your soils. See Figure 2.

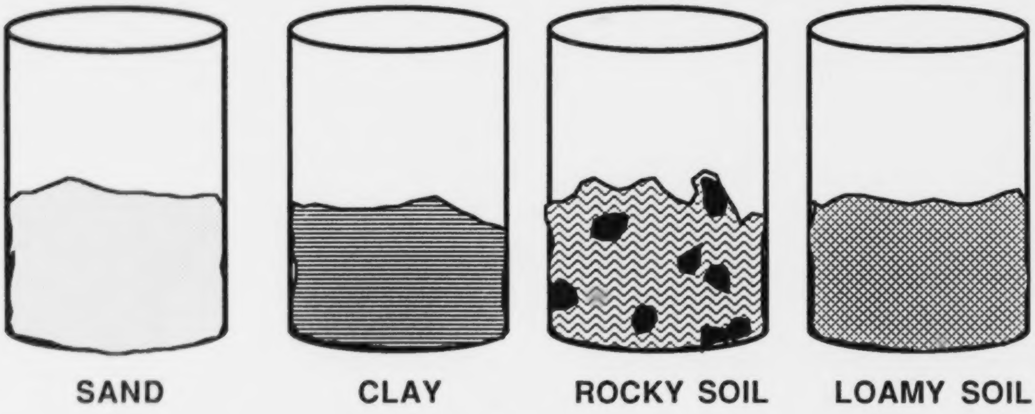


Figure 2
Plastic Transparent soft drink containers with tops cut off
(Note: Beakers can be substituted)

Group the class into groups (4 or 5) for exploring and observing the different types of soils in the containers. Ask them to compare this soil to that which was collected outside. Note differences and similarities. They may record their findings in any way you wish or not at all. See suggested recording form on Student Handout 1. The groups should report their conclusions to the class.

MIDDLE CHILDHOOD ACTIVITIES

Materials: for each group

Materials should be preorganized and available for each group on a work table.

- a half cup of dry clay soil, sand, humus as well as any student samples of soil
- rock samples of limestone (found along roadsides and in driveways) and sandstone (found in rock outcrops or used as garden rocks)
- magnifying lens
- old newspaper or paper towels for keeping work table clean
- small plastic bags for soil collection outside of school

Involve the students in the following activities:

1. Have students bring in samples from home or collect soil in plastic bags from various areas on the school grounds.

2. While working in groups of three or four, each student will examine the different soils at the work area and list characteristics (such as color, feel, etc.) of the soil they observe. The teacher should be flexible and encourage observations of many differences and similarities among the soil samples through touching, smelling and seeing.

3. Ask students to draw what the soil looks like when it is spread out on a sheet of paper. Which soil appears to be very coarse and which appears to be very fine? How should they represent this on paper? Encourage students to explore how they might draw soil and soil particles.

4. Ask students to examine the two types of rocks (limestone and sandstone) and note the physical differences of the rocks. Where do these rocks come from and where can they be found? What types of soils will these rocks produce? Encourage students to rub different combinations of the rocks together. Have them feel the different soils and observe what happens to them when they are wetted.

5. Confront students with the observation that humus is different from clay and sand, and is not the product of rock decomposition.

INVENTING THE IDEA PHASE

TO THE TEACHER:

During this phase of the learning cycle the teacher will play a more directive role. At this time the teacher may wish to refer to notes and background information. The teacher may use inquiry techniques to reinforce exploration activities or simply demonstrate and explain some of the ideas involved in concepts and relationships of soils in the forest.

Students who were not able to answer the problems or events given in the exploration should be led to an appropriate response at this time. Concepts to be introduced and related to the students' past experiences in the *Exploration Phase* include:

- Soil composition consisting of minerals, water, air and organic matter.
- Classification of mineral particles within soil as sand, silt and clay.
- Five soil forming factors including the importance of living organisms and other environmental effects on soil.
- Importance of water as a plant growth/limiting factor.
- Soil horizons.

At the end of this module are diagrams showing relationships between these concepts and a glossary defining these concepts.

EARLY CHILDHOOD ACTIVITIES

Materials: for the class

- 4 clear plastic (2 liter soft drink bottles cut off below middle) or glass containers
- 4 cheesecloth or white cloth pieces 1-1/2 to 2 feet (1/2 meter) square
- soils from Early Childhood *Exploration Phase*
- samples of each kind of classroom soil - sandy, rocky, clay and potting soil
- pipe cleaners or drinking straws
- a mature plant in a container or a seedling just sprouted
- copies of student recording sheets (Student Handout 2)
- measuring cup for distributing equal volumes of soil (This could be a drink or coffee cup with marks on the side.)
- rubber bands (at least eight for securing cheesecloth to the containers)
- felt pens (for labeling containers)
- plastic bags (for soil collection around school)

Involve the students in the following activities:

1. Discuss and have students explore some properties of soil by performing a or b, and both c and d.

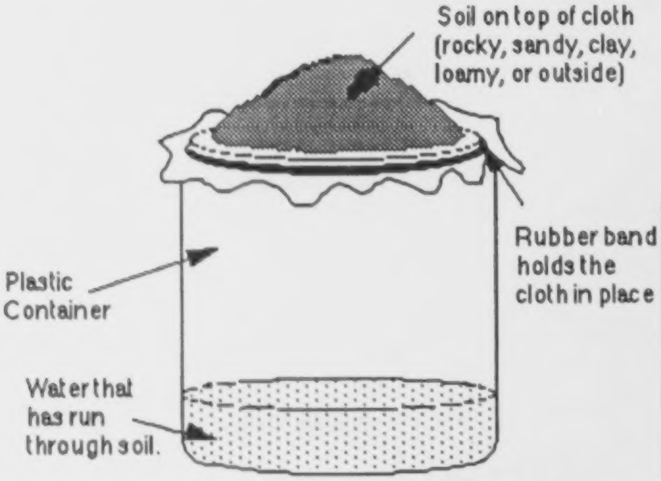
   a) Set up an apparatus similar to that in Figure 3. All the containers should be constructed so that everything is kept uniform. The only thing that varies should be the soil type placed on top.

   Place the cheesecloth as a filter on each plastic container so that when soil is placed on top of the cloth, it is supported away from the bottom of the container. Measure a half inch (one centimeter) from the bottom of the container. Make markings up the side of the container every half inch (one centimeter) with a felt pen. Place the same volume of soil (about one cup) on top of the cloth stretched over each container. Pour one (or two) cups of water on top of each of the soils.

   Ask the group to report what is happening. Emphasize that students watch the rate at which the water runs through the soils. Do this for different soil types.

- How long does it take before the level of water in the first container reaches the first half inch mark?
- Is this amount of time greater or less than that for the second container?

Ask the groups to determine which soil might best absorb water.


Soil on top of cloth (rocky, sandy, clay, loamy, or outside)
Rubber band holds the cloth in place
Plastic Container
Water that has run through soil.

RATE OF DRAINAGE		SOIL TYPE
Fast	Slow	
		clay
		rocky
		good
		outside
		sandy

Figure 3
Soil Drainage

b) Ask students to measure even amounts of different soils into clear plastic cups. Use all four different soils to make comparisons. Measure even amounts of water into cups. Measure half as much water as soil. Pour water at the same time over each of the different cups with soil. Observe the rate of water drainage through each of the different soil types. Ask the group to report what is happening:

- Which soil best absorbs water?
- What happened to the soils as the water was poured?
- Which soil absorbed water at the fastest /slowest rate?

c) Have students clean the cloths and containers. The teacher should be sure that students don't get too much soil down the drains when cleaning. [Soil will clog a drain quickly, it is hard to clean out, and it is very abrasive on the plumbing.] Repeat the water test from Part a or b using the soils that were collected from outside during the *Exploration Phase*.

d) Demonstration of root passage possibilities.
See Figure 4. Place dry soils in plastic jars or cups. Explain that the pipe cleaners or straws will represent the roots of plants or tree seedlings. Ask students in their groups to attempt to push the pipe cleaners or straws through the four different soils. Ask them to report what they discovered about the difficulty of pushing the pipe cleaners or straws through the soils. Discuss the results. Also, repeat this activity using wet soil. Students can compare the two attempts - wet vs. dry.

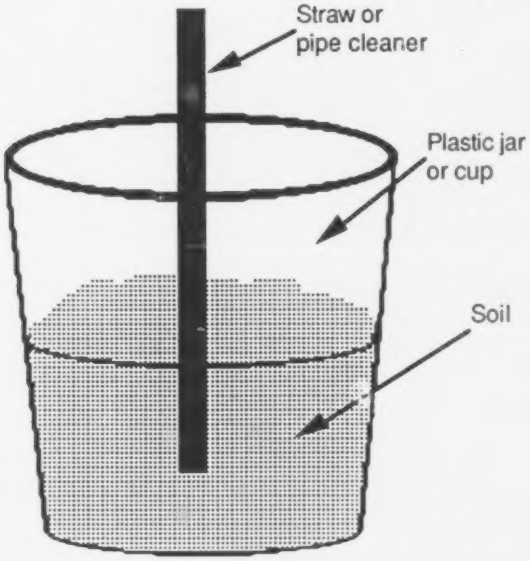


Figure 4
Root Passage Possibilities

2. After the class has been shown a seedling sprouting or a mature plant in a pot, the class should be reminded that soil is the material that seeds grow in. Drawing the students' attention to the soils that they have just observed, explored, and recorded differences and similarities, ask for each type of soil:

   - What might happen if a seed would fall into the (clay, rocky, loamy, sandy) soil from a tree or plant? Would it be able to grow well? Why or why not?

   Discuss what seeds and plants need for good growth opportunity.

   - well drained soil so that the seed would not rot in the soil
   - loose soil so that the roots would be able to penetrate easily
   - soil that is able to absorb and hold some moisture
   - soil compact enough to allow the root system to anchor the plant or seedling

3. Provide closure to the *Invention Phase* by briefly stating in the students' level of language that soils have a definite composition and texture as well as a predictable ability to retain water. Soil texture is the relative amount of sand, silt and clay in a given soil sample and it is this texture which directly affects the moisture content of the soils.

MIDDLE CHILDHOOD ACTIVITIES

TO THE TEACHER:

Before presenting this soil formation activity it may be useful for you to review the concepts of soil formation presented in the background materials at the beginning of this module. Additional information on soil formation follows.

It takes a long period of time for soil to form. In places where the climate is moist and warm it takes thousands of years to form a few inches of soil. In places where it is very cold or in dry desert regions soil development may require much longer periods of time.

Soil is formed through rock weathering which causes the rocks to decompose, or break down. Gradually the surface of the rock becomes softer and decays to become soil. Soil surfaces may also be formed when wind, water or glaciers carry soil from one place to another. Many soils when first deposited will not support much plant life. They usually do not have a large enough variety of minerals in them to allow complex plants, such as trees, corn or wheat to thrive. Soils are capable of supporting crops for the farmer only after they undergo many changes.

As all plants do, forests and trees add materials to the soil. Fallen leaves on the ground are a moisture-holding mulch which turns into brown earth or humus, the most nutrient rich soil on earth. The influence of a forest on soil composition varies with the kind of forest and the region it is in. A bare and open soil quickly becomes compact and impermeable where as a forest floor remains loose and porous. This is due to the protective and insulating action which forest litter (leaves, etc.) serves. This layer, along with the shade provided by the forest trees themselves, reduces the effects of sun, wind and rain on the soil, while at the same time providing the materials to produce more new soil. The bare and open soil does not benefit from these types of protection.

Soil formation is also carried out by chemical means. Minerals composing rocks can be dissolved by water, to be later deposited in soil downstream. Other minerals are chemically changed to form new minerals that are more readily used by plants. Acidic or basic chemical activity conditions brought about by plant life (pine forests create more acid soils) and parent rock in an area can assist in the decomposition of humus material. Also, chemical changes that occur in the organic materials in the digestive systems of animals result in the formation of animal wastes and contribute to humus.

How Soil is Made:

1) Moving air or wind blows sand against rock and wears it away.
2) Rain wears away rocks and carries plant and animal matter into soil.
3) Running water wears down rocks with the help of particles of sand and gravel.
4) Glaciers help to make soil by grinding and breaking loose rocks.
5) Water splits and chips rocks by freezing and expanding in cracks, like a powerful wedge.
6) Biological weathering occurs, adding leaves and debris to the soil to form humus.

7) Chemical reactions aid in decomposing organic materials and minerals, adding new minerals and nutrients to the soil.

SOIL FACTS:

In the 1700's when the U.S. was still largely an uncultivated wilderness, topsoil was an average of nine inches (23 centimeters) deep. Today, 200 years later, the topsoil cover is only six inches (15 centimeters) thick - a loss of one third.

1) In some regions water and wind have eroded as much as 1 1/2 feet (46 centimeters) of rich topsoil from the plowed land that surrounds the untilled plot, strongly protected by grass.

2) Careless and unwise use of land can speed up the loss of the nation's topsoil by erosion.

3) Cover plants may save as much as 3,000 pounds (1,364 kilograms) of soil from washing off one acre (4,047 square meters) a year. Forest land loses much less soil per year to erosion than farmland, because the deep root systems of trees anchor the soil much better than shallow rooted farm crops. Also, plowing and tilling add to the deterioration of topsoil.

Involve the students in the following activities :

1. Activity on soil formation.

Materials: for each group
- 2 pieces of limestone (can be found along roadsides or driveways)
- 2 pieces of sandstone (can be found in rock outcrops or as garden stones)
- eyedropper
- magnifying glass

Working in small groups ask each group of students to:

a. Take two pieces of limestone. Rub them together over a white sheet of paper. Label the paper "limestone soil."

b. Take two pieces of sandstone. Repeat the process. Label the second sheet "sandstone soil."

c. Compare the two piles of particles. List similarities and differences.

d. Add water, just a few drops, to the two piles. Compare results. Add more water. Any different observations? Make new observations and comparisons.

e. Discuss the concept of soil formation--speed, types, etc. Relate concepts to student activities.

2. Activity on soil layering

TO THE TEACHER:

Soils develop into layers, usually called horizons; these layers can be viewed when areas of soil are exposed or when traveling along road cuts. There are usually four horizons in a soil profile. The thickness of each horizon can vary with location and not all of the horizons will be present.

The uppermost soil layer is called the organic horizon or O horizon. This layer consists of leaf litter and other organic material lying on the surface of the soil. The layer is dark because of the decomposition that is occurring. In cultivated fields, this layer is not present.

Below the O horizon is the A horizon or topsoil. Usually, this layer is darker than lower layers, loose, and crumbly with varying textures. In cultivated fields the plowed layer is topsoil. This is generally the most productive layer of soil. As water moves down through the topsoil, many minerals and nutrients dissolve in this water. Those materials that are soluble are then carried downward to the B or C horizons.

Below the A horizon is the B horizon or subsoil. Subsoils are usually light colored, dense and low in organic matter. This zone is where most of the materials that are leached from the topsoil by rainwater accumulate.

The C horizon is a transition area between soil and parent material. Partially disintegrated amounts of organic matter make up the C horizon. Parent materials and mineral particles may be found in this horizon. The final horizon is bedrock.

The following activity allows students to learn about the soil horizons and the process of layering. The teacher may also wish to refer to the transparency at the end of this module which illustrates a hypothetical soil profile.

Materials: for each group
- 1 large 32 oz. (one liter) jar with screw-on lid (mayonnaise or canning jar)
- measuring spoon
- sand
- potting soil (loamy soil containing humus)
- clay
- Student Handout 3

TO THE TEACHER:

Special advanced preparation is needed for this activity. Materials should be preorganized and available for each group on a work table. The sand, potting soil and clay should be allowed to dry thoroughly before this activity. Wet soils will not perform as desired. If a school grounds field trip is to be taken for d) below, locate an area where some soil layering is visible. You will need a shovel to try this. Check possible undisturbed areas away from the school building.

a) Working in small groups ask each group to take a 32 oz. (one liter) jar. Have them fill the jar with 1/2 cup (125 ml) each of sand, potting soil and clay.

b) Shake the jar for about 1 minute. Let the mixture settle.

c) Draw in a notebook the layers seen after settling.

d) Discuss how this might compare to soils found outdoors. How might this soil be deposited? If time is available have students visit a site on the school grounds where soil layering is visible.

e) In a whole class activity, discuss the concept of soil layering (horizons). Use Student Handout 3 either as a transparency or worksheet. Discuss the experiences from the *Exploration Phase* also.

3. Activity to determine soil texture.

Materials: for each group
- several mixtures of various soils (eg. clay, sand, potting soil, and two or more soils collected from the local area)
- water
- Student Handout 4

a) Dampen a small sample of soil and attempt to roll it between your hands to form a ribbon or log.

b) Observe and feel the resultant ribbon of soil.

c) Use the soil texture determination method shown in Figure 4 below (Student Handout 4) to help determine the type of soil. Select the most accurate description of the three listed on the right side of the pyramid.

d) Next, observe a dry sample of the same soil and estimate the percent of sand and clay. Select the most accurate description on the bottom of the pyramid. Using the pyramid diagram, locate these estimates along the side and bottom. Place a finger at the location of the estimates. Move both of your fingers at the same speed until they meet inside the pyramid. The location of the meeting point should be within the area which best describes the soil composition. One should be able to estimate the relative percentage of each soil component, clay, sand, and silt.

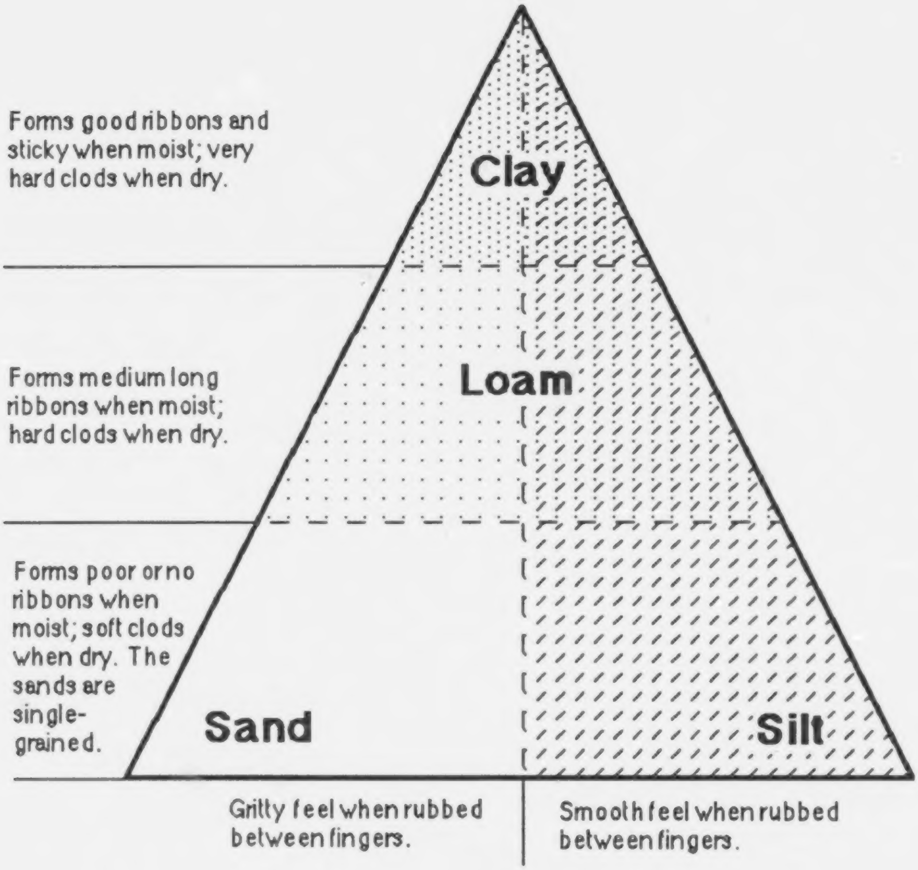

Forms good ribbons and sticky when moist; very hard clods when dry.
Clay
Forms medium long ribbons when moist; hard clods when dry.
Loam
Forms poor or no ribbons when moist; soft clods when dry. The sands are single-grained.
Sand
Silt
Gritty feel when rubbed between fingers.
Smooth feel when rubbed between fingers.

Figure 4
How to Determine Soil Texture by Feel

4. *Optional: Activity on pH of soils. A small group activity.*

TEACHER NOTE:

Special advanced preparation is needed for this activity. Acidity of a soil can have significant effects on plant growth. The degree of acidity can be measured on the pH scale. The pH scale range is from 0 to 14; neutrality occurs at pH 7. Values below 7 are acidic, and values above 7 are basic or alkaline. Because pH is a logarithmic measurement, pH 6 is 10 times more acidic than pH 7, and pH 5 is 100 times more acidic than pH 7.

Most plants grow best when the pH of the soil is 6 to 7, but certain species such as blueberries, cranberries, azaleas, camellias and some hollies grow well only in a lower pH soil. Also, some minerals are more easily absorbed by the roots of plants at a specific level or are not absorbed below or above a specific level. Thus, pH can regulate what trees are able to take in from their environment.

Materials: *for each group*

- *measuring spoon and eyedropper*
- *pH paper, hydrion paper, or litmus paper*
- *sandy soil,1 gallons (4 liters) for the class*
- *potting soil, 1 gallons (4 liters) for the class*
- *peat soil, 1 gallons (4 liters) for the class*
- *buffer solutions of pH 4,6 and 10 (approximately) obtain from a local high school or from a chemical supply company*
- *distilled water*

Ask students to perform the following activities,

a) Test each of the three buffer solutions with a separate piece of pH paper. Lay these papers next to the respective solutions for use as standards of comparison for test on the various soil samples.

b) Place 1 tablespoon of each of the soil types (sandy, potting and peat) on paper mats. Label each mat.

c) Wet each of the soils with 5 drops of water distilled or to a damp consistency and mix thoroughly. Allow mixture to sit for 3 to 5 minutes.

d) Place pH paper on each of the soil types. Record if the soil is acidic or basic and if possible the level of acidity.

e) Graph the acidity of each soil type as shown in Figure 6. Arrange the soils from basic to most acidic. In a whole group discussion compare results and draw a pooled data graph on the blackboard. You may also want to test the soils formed from the rocks in the soil formation activity from above.

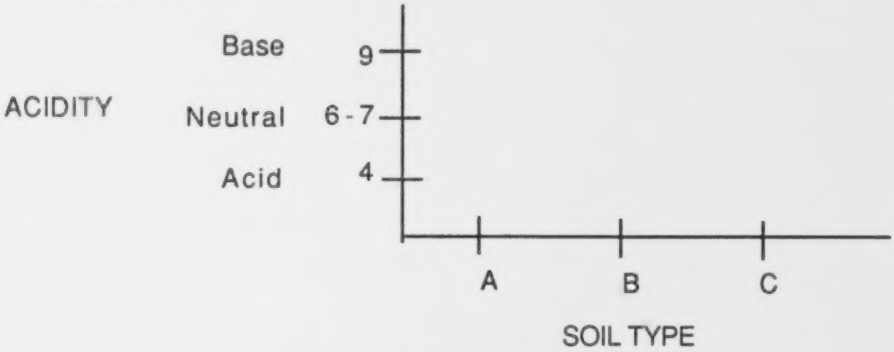


Figure 6 - Chemical Activity of Soils

5. As a closure to the *Invention Phase* discuss how the variables of layering, soil formation and chemical activity might affect plant and tree growth in forests, and urban settings.

- Are all soils the same?
- What causes some of the soil differences?
- How else might soils differ?
- What is the evidence?
- How might plants be affected? Growth? Root growth?
- What soils would support the fastest growing and tallest trees? Why?
- Ask students to make inferences about the relationships between plants and the soil environment.

EXPANDING THE IDEA PHASE

In the final learning cycle phase the student must use and apply facts, concepts and relationships concerning soils in the forest. Students should refer to cumulative information in journals, fact sheets, etc. New contexts and different ways of looking at the ideas explained in the earlier part of the lesson should now be attempted. Following the *Expanding The Idea Phase,* the teacher should check student outcomes with a quiz, performance test, and/or discussion. Instruct students to save notes, drawings and charts in a notebook for future reference.

EARLY CHILDHOOD ACTIVITIES

Materials: for the class

- A large supply of sandy soil, clay soil and rocky soil and loamy soil
- 20-25 magnifying glasses
- 20-30 clear plastic containers - cups
- *20-25 seeds (bean)*

Involve the students in the following activities:

From what the class has discovered earlier they should be able to determine which soil may be best for plants to grow. Have students perform one of the following two, a or b, activities.

1. Ask them to create a soil that they think would be ideal for plants and trees to grow in. Let the groups demonstrate and justify their choice by replicating the experiments attempted earlier in class.

   or

2. Take the class outside and using only observations of plant (include trees) growth around the school have them predict where the best soil for support of plant life may be. Have them justify their answers with what they have learned about soils. Allow them to collect soil samples and perform the experiments that were done in class.

3. *Optional: Ask the students to plant 1 or more seeds in the ideal soil created in the activity. Have them care for the plants until germination. Put in a warm place in the room. If the weather is appropriate have them plant the germinated seed out of doors in what they determine as good soil.*

4. *Optional: Using Student Handouts #3 and 4 answer the following questions: What evidence of plant and animal life do you see in the soil diagram? What do each of these plants and animals do in the soil, to the soil, use in the soil? Are there soil layers? Have you seen living things in the soil samples you gathered outside? Can you identify them? Make a drawing of soil showing living things you have seen.*

MIDDLE CHILDHOOD ACTIVITIES

Materials: for each group
- 6-9 bean seeds
- 3 pots
- sandy soil, clay soil, humus
- graph paper, one for each student

Note: This activity requires the teacher to germinate seeds in a tray on a damp paper towel at least two days prior to the day needed. Keep covered with a damp paper towel.

Involve the students in the following activity:

1. Effect of soil type on plant growth activities

These activities will take place on three days spread over a six day period.

a) Ask each student to plant an equal number of germinated seeds in 3 pots, one of each soil type.

c) Predict future growth events for the sprouted seed.

d) Compare these soils to specific sites and areas in the local area.

e) Three or four days later, after observing growth of the sprouted seed; note the best growth plant from each student group. Are the best growing plants the ones potted in the same types of soil?

f) Using the best growth plant from 3 student groups add a watering mixture of pure vinegar to one plant, 1 part vinegar to 2 parts water to a second and regular water to a third plant.
- Ask students to predict the results. (Remember that vinegar is acidic.) Have them graph the growth for 3 days.

g) Compare results of the best growth plants in the special acidic water with the other plants. Discuss results, and relate it to the growth of plants in general and to large forest areas.

EVALUATION:

Bring the results from the students' investigations together and pose the following summary questions:

1. What is soil?
    a) What are the major components of soil?
    b) How do soils differ?

2. What are some important characteristics of soil types and horizons?

3. How is soil made?
    How do plants affect soil characteristics?

4. How do plants effect soil?

Discuss students' own investigations and findings.

FINAL EVALUATION

Teacher may wish to evaluate student journals recorded during this module, including recordings, drawings and graphs. Additional evaluation should consist of a short test for evaluating terms and some problem questions requiring higher order thinking skills on soil formation, effects and properties.

GLOSSARY

Humus - highly decomposed plant and animal residue that is a part of soil.

Leaching - the removal of soluble minerals from soil by the downward movement of water.

Mineral - a naturally occurring inorganic substance with definite chemical and physical properties and a definite crystal structure.

Nutrient - a substance that supplies nourishment for an organism to live. It can be food or chemicals depending on the organism.

Organic matter - plant and animal material in various stages of decomposition that may be part of the soil.

Parent material - the earthy materials, both mineral and organic, from which soil is formed.

Permeability - the quality of soil that allows air or water to move through it.

Poorly developed soil - soil made up of undifferentiated layers (horizons).

Pore spaces - the areas of the soil through which water and air move. The space between soil particles.

Soil - a naturally occurring mixture of minerals, organic matter, water and air which has a definite structure and composition and forms on the surface of the land.

Soil color - the color of a sample of soil.

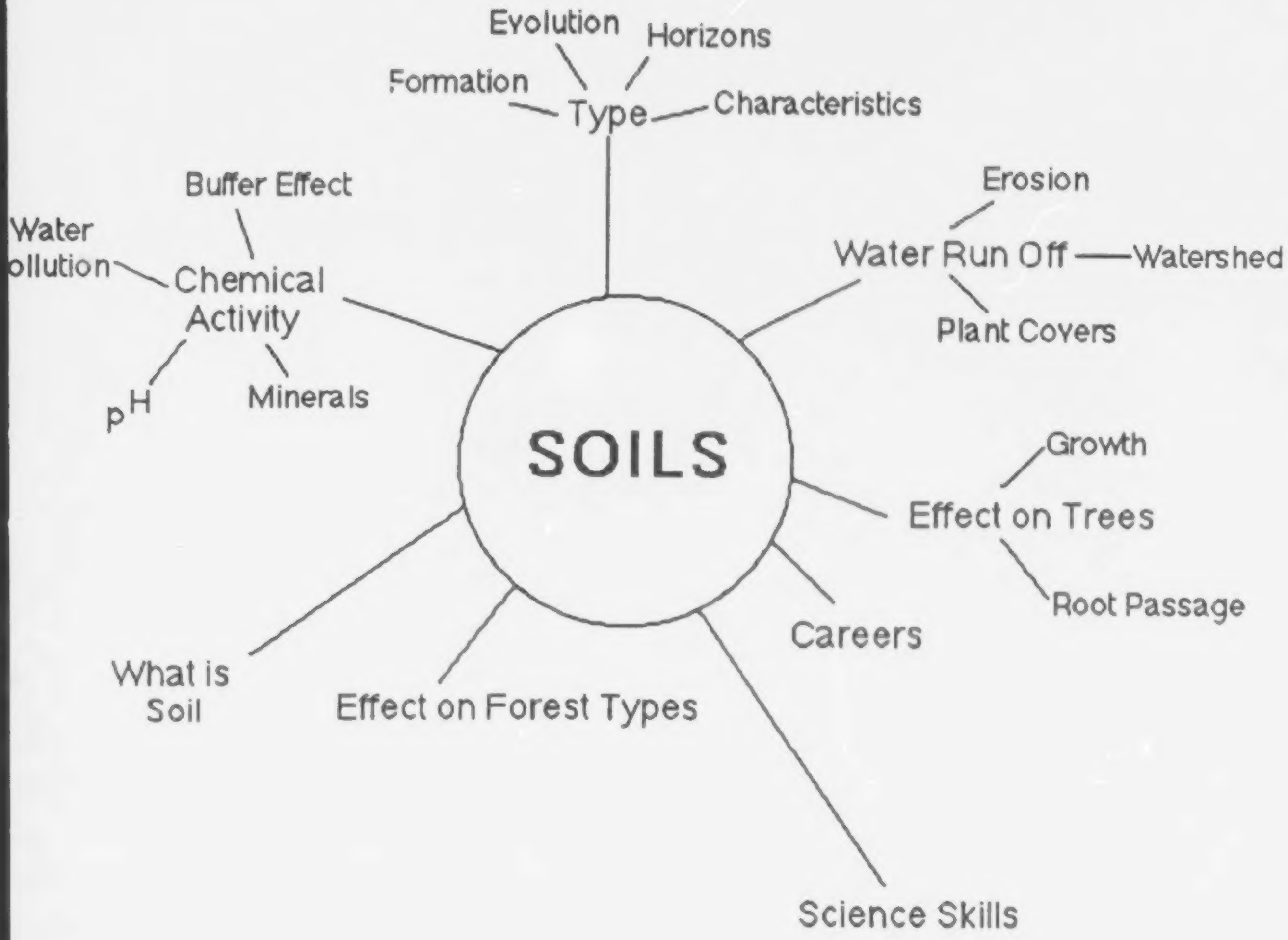
Soil horizon - a layer of soil that is nearly parallel to the land surface and is different from layers above and below.

Soil mineral - that portion of the soil that is inorganic and neither air nor water.

Soil texture - the relative amounts of sand, silt and clay in a given soil sample.

Well developed soil - soil containing all of the differentiated layers (horizons), and thus a sufficient amount of minerals and nutrients to support plant growth.

SOILS OF THE FOREST


SOILS
Type
Formation
Evolution
Horizons
Characteristics
Chemical Activity
Buffer Effect
Water
ollution
pH
Minerals
Water Run Off
Erosion
Watershed
Plant Covers
Effect on Trees
Growth
Root Passage
Careers
Science Skills
Effect on Forest Types
What is Soil

STUDENT HANDOUT 1

Soil Data Sheet

Your Name____________________

Where soil was found____

Circle answer in each box which describes your soil.

Wet Dry

Compact Loose

soil only
other stuff
Describe_____

Easy to collect Hard to collect

rocks no rocks

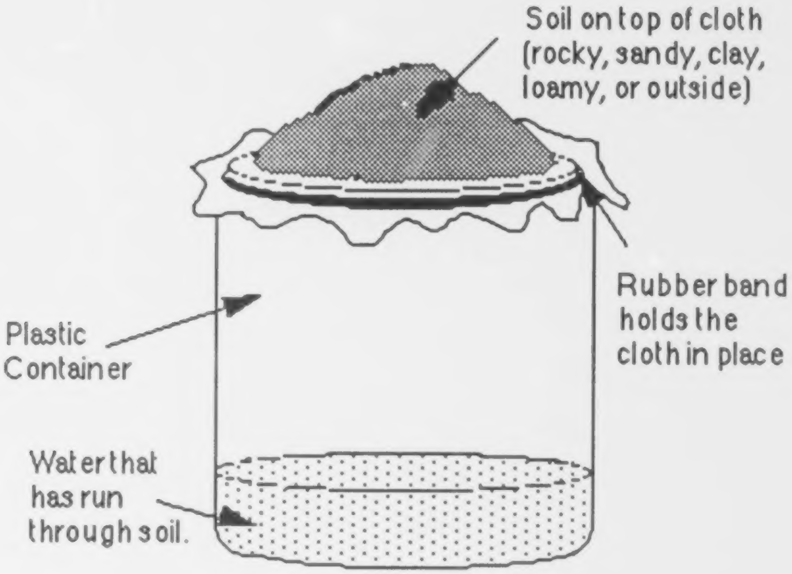
Write the results of the comparison on the blackboard. A sample is shown below.

Student collected soil
wet
compact
rocky
insects
clay
stuff from trees

Classroom soil
dry
loose
sandy

STUDENT HANDOUT 2

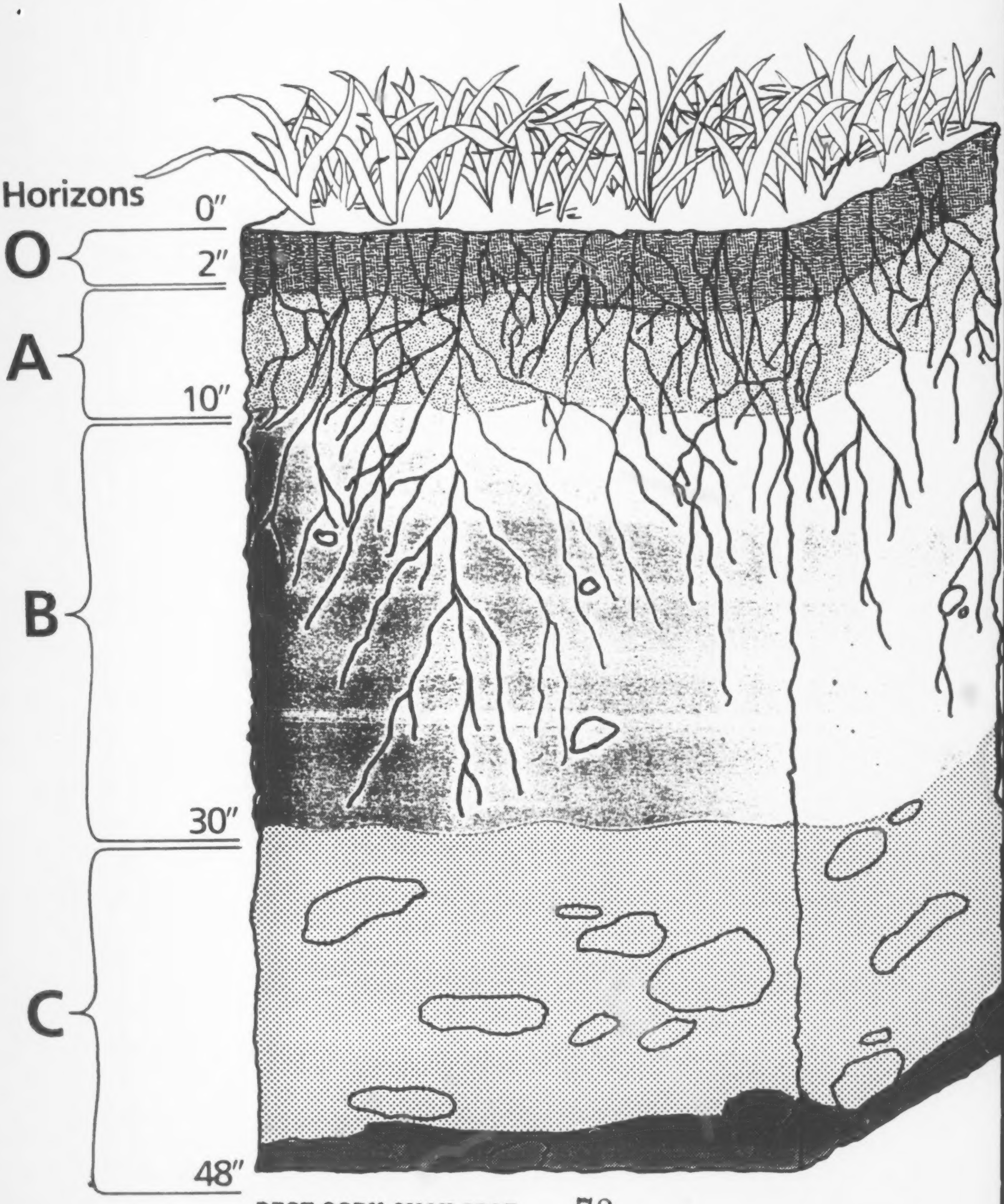
Soil Drainage Worksheet


Soil on top of cloth
(rocky, sandy, clay,
loamy, or outside)
Rubber band
holds the
cloth in place
Plastic
Container
Water that
has run
through soil.

RATE OF DRAINAGE		SOIL TYPE
Fast	Slow	
		clay
		rocky
		good
		outside
		sandy

STUDENT HANDOUT 3

Exposed Soil Showing Horizons


Horizons
0″
O
2″
A
10″
B
30″
C
48″

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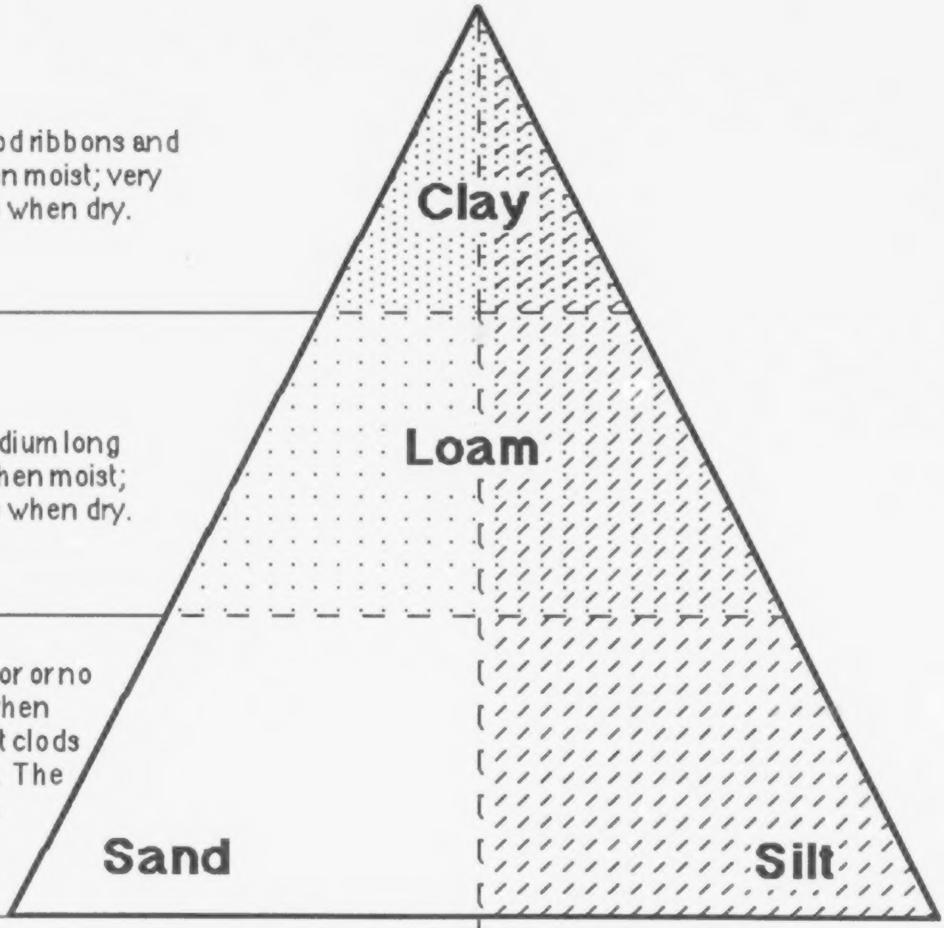
STUDENT HANDOUT 4

How to Determine Soil Texture By Feel



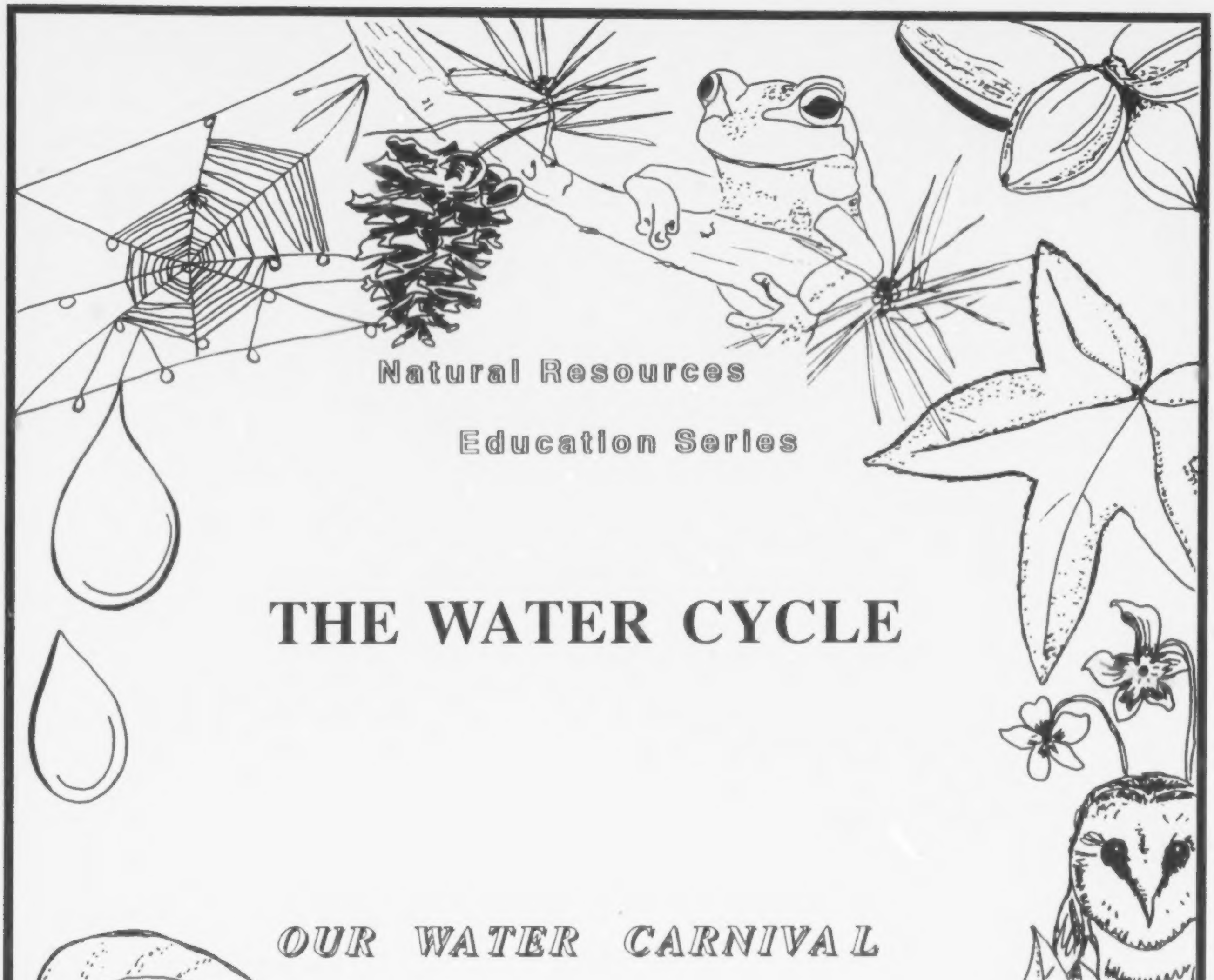
Forms good ribbons and sticky when moist; very hard clods when dry.

Forms medium long ribbons when moist; hard clods when dry.

Forms poor or no ribbons when moist; soft clods when dry. The sands are single-grained.

Gritty feel when rubbed between fingers.

Smooth feel when rubbed between fingers.



Natural Resources

Education Series

THE WATER CYCLE

OUR WATER CARNIVAL

BEST COPY AVAILABLE

The writing, development and, production of the *NATURAL RESOURCES EDUCATION SERIES* is a joint project with collaboration of project directors Dennis W. Sunal, The University of Alabama, and Mary E. Haas, West Virginia University, and the U.S. Forest Service. Partial funding was provided by the U.S.D.A. Forest Service. The initial author and series editor was Dennis W. Sunal. Revision of individual modules was carried out with the help of Mary E. Haas, and Cynthia S. Sunal. Assistance in creating appropriate activities, proof reading, and creating art work by computer for the many editions was provided by Jon Berninzoni, Elwin Dickerson, Tracy Johnson, Jane McGinnis, and Sukhwindar Singh. Final editing assistance on the text and artwork was performed by Audrey Rule. William Kline, Jr. assisted in training the original trial teachers. Content reviewers were specialists in the various module topics at the U.S. Forest Service including Monongahela National Forest staff members, Theresa Anne, Randolph Harrison, Linton Wright, and Harry Mohoney, and Northeastern Forest Experiment Station, Timber and Watershed Laboratory staff Pamela Edwards, David Helvey, James Kochendorfer, and Clay Smith. Teachers in the Randolph County, West Virginia Schools who first taught the modules and made recommendations for revisions were: Sandra Arbogast, Sara Basil, Ann Deloach, Karen Hall, Richard Leitner, Elizabeth McDonald, Linda Moore, Sharon Moss, Pam Mullennex, Jeff Ranhart, Theresa Skidmore, Rachel Snavely, Charles Swecker, Nancy Taylor, Angela Vance and Rebecca Wallace.

The *NATURAL RESOURCES EDUCATION SERIES* is designed to supplement textbooks with active learning lessons for students in the primary and middle childhood grades (K-8). The series consists of Understanding Our natural Resources Teacher's Guide and 12 Modules including Appreciation of Natural Beauty, Soils and Plant Growth, The Water Cycle, Natural History of a Tree, Recipe for Tree Growth, Tree Growth and Environment, Forest Processes, Managing Our Forest Resources, Growth of a Forest, Interactions of Forest Plants and Animals, Natural Watersheds, and Managing Our Natural Resources.

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THE WATER CYCLE

THE WATER CYCLE

Our Water Carnival

BACKGROUND INFORMATION FOR TEACHERS

This module would be appropriate with chapters in existing texts relating to water processes, plants, weather, climate and life, earth's resources, and where plants and animals live. Living things need water to carry on their life activities. Water processes involve those cyclical actions which replenish the available water resources of this planet.

The purpose of this module is to increase students' understanding of the water cycle through the processes of evaporation and transpiration, condensation, and precipitation. The module activities require several days to complete, but are flexible enough to be shortened or extended to fit the teacher's schedule. The teacher is advised to read ahead because some advanced preparation time is needed.

Water has been described as the essence of all life on earth. Seventy percent of the human body is composed of water and approximately the same percentage of the earth's surface is covered with this vital resource. However, most of the earth's water is salty (98%). In the United States, about 360 billion gallons of fresh water are used daily. As with other valuable natural resources, water can be carefully managed or squandered. Effective water management, however, requires a sound knowledge of the processes involved in the circulation of water on the surface, under the land, and in the air. The circulation of water between the earth and the air is known as the hydrologic or water cycle.

The endless and all-prevailing hydrologic cycle is composed of several pathways. Solar heating causes water from both sea and land to evaporate and become atmospheric water vapor. As the surrounding air cools, this water vapor then condenses as small droplets to form clouds. When the water droplets become larger, precipitation in the form of rain, sleet, or snow occurs. Precipitation falling on the land can accumulate and run over the surface as streams and collect as bodies of water (ponds, lakes). The water may also sink into the soil subsurface. Percolation is the movement of water through the soil. Water moves as the result of many forces in the soil, but mostly by gravity and capillarity. In the latter case, the water is pulled by surface tension through the small spaces between the soil particles.

Root hairs, extremely thin projections near the tips of plant roots, push their way into the small spaces in soil and absorb water. Only a small fraction of the absorbed water is used in the plant for photosynthesis. After extracting the minerals in the water, plants release a great proportion of the water into the air by the process known as transpiration. Thus, the water cycle is perpetuated when water vapor re-enters the atmosphere through evaporation from bodies of water and soil, and through transpiration from the leaves of vegetation. The processes of evaporation and transpiration frequently are described in combination by the term evapotranspiration.

When looking at an area of land in terms of the amount of water required to produce maximum plant growth, we need to look at both the evaporation of water from the soil surface and the transpiration of water lost from plant leaves. The rate of evapotranspiration is affected by a number of factors, including the relative humidity of the air, wind speed, air temperature, light intensity, soil conditions, and vegetative cover (examples: forest, grass, or crop growth).

OBJECTIVES: Choose those appropriate for your students.

-Develop and practice observation and recording skills.

-Identify and describe the three physical states of water.

-Identify and describe the components of the water cycle: evaporation, transpiration, precipitation and condensation.

-Demonstrate the cyclical nature of the water cycle.

-Explore the relationship between plants and evaporation of moisture (evapotranspiration).

-Predict changes and effects that the water cycle process has on living things, such as trees, in a given environment .

EXPLORATION PHASE

To The Teacher:

The initial phase of exploration involves interactive activities using observation and other science process skills to help students, on their own, to discover basic concepts and relationships in the water cycle. The teacher should use this time to organize groups, observe interactions, and permit students to investigate possibilities themselves. Students should be asking questions, gathering first-hand information, and making connections to their previous experiences and conceptions in and out of school. Ideally the student should be confronted with a problem or event which cannot be explained by past knowledge.

EARLY CHILDHOOD ACTIVITIES

Materials: for each group
- Student Handout 1 and 2
- notebook or tape recorder to record student observations
- measuring tape or meter stick

- wood stakes, five, about 1/2 foot (15 cm) long
- table or counter on which to set each observation center
- styrofoam plate
- sponge
- flowerpot with soil in it
- 1 sheet, 8.5 x 11 inch (20 by 27 cm), construction paper
- sealable jar
- 5 ice cubes

Involve the students in the following activity:

1. A large and small group activity on water cycle observation.

Note: Activity one requires the gathering of data on two separate days, and incorporates observations both inside and outside of the classroom.

Day 1

Outside Observations:

A. After a rainy day take the class outside to find/look for wet and dry areas around the school building, under trees, and in areas with different types of vegetation. Ask the class: Why are some areas wetter than others? Identify the ways ground can get wet (forms of precipitation, condensation, and runoff). How might the wetness or dryness of the areas affect how the plants, trees, and grass grow? Ask students to observe and discuss the height, type, and quantity (a lot, a little, bare, etc.) of growth in the areas selected. Stake out 4 or 5 areas for group observations and record keeping on Student Handout 1. Use short pieces of wood, flush with the ground. Assign a group of students to each site during this first day. Have the students observe and record the results seen. This outside activity will continue over 4 days.

Inside Observations:

B. Ask the students to make observations of ice cubes set up on different materials. Ask students to place ice cubes in five places: on a plate, on a sponge, on a piece of construction paper, on top of the soil in a flowerpot, and in a jar with the lid sealed. (See Student Handout 2)

C. Ask each student group to observe and record their observations on Student Handout 2 every ten minutes until the ice melts. Ask students to make drawings to describe the results. They may want to write about what was seen below each drawing.

D. Ask each observation group to report what they think happened to the ice cube.

E. Guide the students to make comments on all activities by summarizing their observations from Day 1. Compare and contrast the indoor and outdoor observations on evaporation (water changes into a gas called water vapor), condensation (water vapor changing back to water) and precipitation (water returning to earth as rain, snow, hail or sleet). Guide them to make further comments on events similar to those they have previously experienced.

Day 2

A. Make another brief, five to ten minute, observation of the outside sites. Ask the students to discuss what is happening and what they think has happened since their last observation.

B. Bring the class inside and ask groups to observe what has happened to their inside experiments and discuss what they observe. Have each group make a report to the rest of the class.

C. Activity to demonstrate condensation. This activity is done inside the school, by the teacher, or a supervised "teacher's helper."

***Materials*:** for the demonstration
- saucepan with lid
- water
- hot plate

1. Note for the students that the saucepan and the inside of its lid are dry.

2. Fill saucepan half full water. Note the water level. Bring to a boil and cover with the lid. Continue to boil for three minutes more. Allow students to examine the lid. What is observed on the inside of the lid? What is happening there?

   If you can see "steam" come out of the pan remember that this is already condensed water vapor in the form of small water droplets. You cannot see evaporation or water vapor - only the results of it: bubbles in the water, decreased water volume, and "steam."

MIDDLE CHILDHOOD ACTIVITIES

TO THE TEACHER:

In the next activity, the purpose of comparing the drying rates of soil is to allow the students to see the loss of moisture from the sand due to evaporation and then from soil and a plant due to evaporation and transpiration.

1. Activity to compare drying rates of soil. This activity requires 3 days to complete.

Materials: for the class
- 2 paper cups
- sand and potting soil
- weighing device (e.g. pan scale, spring scale, triple-beam balance)
- water
- small house plant in a pot of sand or potting soil
- plastic wrap
- small plastic bags

Involve the students in the following activities:

Days 1 to 3

A. Form groups of about three students each. Assign group roles of observer, recorder, and a leader responsible for materials. Compare the drying rates of soil. Put a paper cup on a weighing scale. Fill it half-full of sand or potting soil and weigh it. Remove the first cup from the scale and put on a second cup. Fill the second cup with sand or potting soil so it weighs the same as the first one. Dampen one cup with water. Pour enough water in the second to make it very wet. Weigh both cups to find their new weights with water. Record the weight of each cup on chart paper. Record the weights of both cups for 3-5 days as the sand dries out.

B. Repeat the soil drying experiment in another form. Weigh a small plant in a pot when the soil is quite dry. Record its weight on chart paper. Water the plant well. Record its watered weight. Wrap the pot with plastic wrap leaving only enough space for the stem and leaves of the plant to be exposed to air. Weigh the plant daily. It should weigh less as transpiration occurs through its leaves. If possible, part of the time cover the plant and pot with a large glass jar. Moisture should collect on the inside of the glass jar after transpiration through the leaves.

C. Tie plastic wrap around some leaves growing on various plants in the classroom or on the school grounds. Make sure only the leaf is covered and that no part of the leaf stalk is included. Examine the covered leaves at intervals throughout the day or during the same period the next day. Record observations. The class may want to repeat their observations using similar leaves during different weather conditions, such as cloudy, sunny, chilly and warm. Record observations. Are there any occasions when water appears to collect more quickly in the plastic bag?

D. The students should describe the changes they observe each day and offer their explanations for what they believe has happened and will happen next.

2. Activity to introduce the concept of the water cycle, to be completed on Day 3.

Materials: for each student
- regional or world map or globe
- foam or paper cups filled with tap water to be placed on student desks
- writing materials

Involve the students in the following activities:

A. Divide the class into groups of 3 or 4. Distribute cups of water to each group.

B. Say to the students "Some of the water you drank today may have been part of the Amazon River's water. However impossible this may seem, it makes sense when you think of where rainfall (precipitation) comes from." Distribute maps or globes to student groups and involve them in a discussion and activity in which they locate the major bodies of water in the world (oceans, rivers, and lakes). Have the students locate the sources of these major bodies of water and trace the paths of the rivers. Once the students have completed the above, involve the students in a brainstorming activity where they are asked to describe and discuss in concrete detail how the water from the Amazon River may have ended up in their drinking cups.

NOTE: This activity can also be modified to focus purely on local major lakes and rivers using a state or regional map. Details should include water evaporation, condensation to clouds, rain infiltration into the ground, taken up by plant roots, and evaporated by leaves into the air. This may occur many times with different types/forms of events before it becomes personal drinking water.

C. *Optional: Additional questions at this stage might be:*

1. Can water, which might have fallen on the continent of Asia fall again on your community? Explain.
2. How much fresh water is found on Earth?
3. Is it possible for people on earth to run out of water, both salt and fresh water?
4. What are some factors that affect the amount and quality of water near a land area?
5. Where is water during droughts? How might droughts occur?

INVENTING THE IDEA PHASE

TO THE TEACHER:

During this phase of the learning cycle the teacher will play a more directive role. At this time the teacher may wish to refer to notes, background information, etc. The teacher may use inquiry techniques to reinforce the *Exploration Phase* activities or simply demonstrate and explain some of the ideas involved in the water cycle. Students who were not able to answer the problems or events given in the *Exploration Phase* should be led to an appropriate response at this time.

EARLY CHILDHOOD ACTIVITIES

Materials: for the class

- pictures or diagrams of the concepts of evaporation, condensation and precipitation. These may be found in the students science textbook, magazines, or library books.
- writing materials or a cassette recorder and tape
- pencils, pens, crayons for drawing.

Materials: for a demonstration

- Figure 1 to be used as a transparency or as the basis for a board drawing
- 1 cup (250 ml) of boiling water
- a quart (100 ml) size container of ice cubes
- 1 drinking glass with very cold water in it or placed in a container of ice cubes
- a cold mirror (set it in ice cubes)

Involve the students in the following activity:

Day 3 (Not necessarily immediately after Day 2)

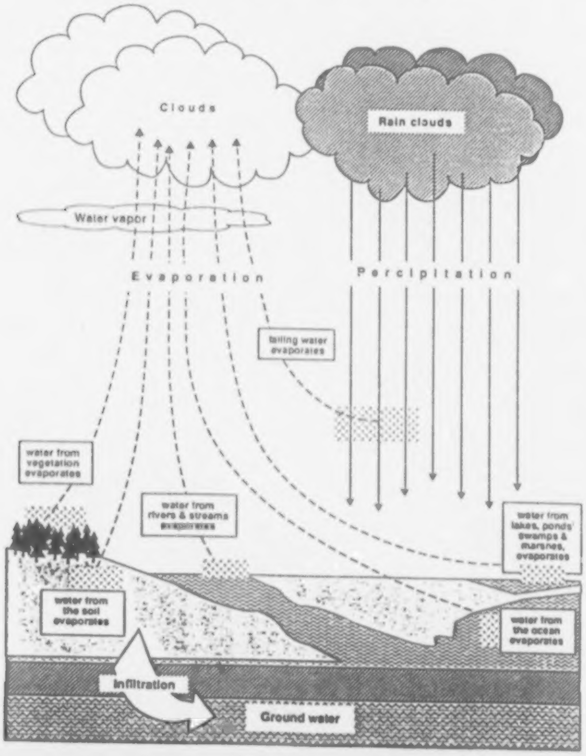
1. Take class to the outside sites for observations and discuss the effect of too much or too little water on plant growth. Describe or point out color changes, wilting, or poor growth. Point out plants which tolerate different levels of dryness or wetness (e.g. grass, cactus, vs. annual flowers and moss).
2. Inside the classroom hold a cold drinking glass over a cup of hot water, slightly tilting the glass. Ask students to observe what is happening and record what they see (perhaps you might have a prepared recording sheet picturing the experiment). They should be able to see the effects of water condensing on the cold glass and dripping back (precipitation) onto the container of hot water. Ask students to identify forms of precipitation and condensation. Complete the list for them, if needed (precipitation = rain, snow, hail; condensation = dew, frost, fog). Use Figure 1 as a transparency, blackboard drawing, or handout. See below and in appendix.
3. Ask class if they noticed anything similar in their inside and outside observations. If not, ask why not. If so, ask for an explanation.
4. Provide information about water and the water cycle if students have not come

to these conclusions or inquired about some of the properties of water. Introduce and operationally define (show or recall an example they just experienced) the concepts of evaporation, condensation and precipitation. Ask the students to illustrate some of the concepts with drawings and/or colored pictures.

- evaporation and precipitation are opposites in the water cycle (taking water away from an area and adding water to an area).
- water has three states: solid, liquid and gas. Water can change from one to another.
- water is essential for plant and animal survival.
- plants and animals give off water vapor (You can demonstrate this by breathing on a cold mirror).
- warmer temperatures create faster evaporation (Try activity 2 above with 2 cold glasses, and exclude the hot water.).
- when water evaporates, cooler temperatures are produced. Heat energy is needed to change water into water vapor.
- water can be evaporated, condensed, and precipitated over and over again. Water never "wears out."
- condensation is the first step in the process of precipitation.
- the result of condensation is not always precipitation. Clouds can evaporate and grow smaller in size.
- the sun provides the energy for the water cycle to work.

5. Provide a closure to the *Invention Phase* by briefly stating in the students' level of language that the water cycle occurs in a never ending continuous pattern. The natural processes of evaporation and condensation lead to precipitation in many forms. Plant growth (grass, trees, shrubs) is affected by too little and too much water. Plants have different toleration levels to dryness and wetness.

Figure 1 - The Water Cycle


Clouds
Rain clouds
Water vapor
Evaporation
Percipitation
falling water evaporates
water from vegetation evaporates
water from rivers & streams evaporates
water from lakes, ponds' swamps & marshes, evaporates
water from the soil evaporates
water from the ocean evaporates
Infiltration
Ground water

MIDDLE CHILDHOOD ACTIVITIES

TO THE TEACHER:

The following middle childhood activities require some structured organization followed by teacher guidance. After a structured beginning the teacher should become a facilitator and encourage students to explore on their own. The students in their previous science lessons should have experienced each of the water processes.

1. Activity using the game "Water Cycle Charades"

Materials: for the class
- 1 small plastic watering can with spout
- 1 graduated cylinder (100 ml) filled with 50 ml (1/4 cup) of water
- 1 plastic tablecloth or plastic covering that adequately can cover a student
- 3 100-ml (1/2 cup) glass beakers
- large note cards with the words condensation, evaporation, precipitation, infiltration and transpiration written with a dark marker. Tie string on each so that it can be worn by a person.

Note: Other containers and materials can be substituted wherever appropriate.

Involve the students in the following activities:

1. This game of Water Charades engages all of the students in the class and provides an active way for the students to view the connectedness of water and the water cycle. Prior to this activity, directions must be given to six student volunteers. Appropriate safety measures need to be observed with some of the materials.

   A. At the beginning of the class period ask for student volunteers and meet with them as a group.
   B. The following scenario is enacted in front of the class several times; there is no talking from any of the participants in front of the class or the teacher.
   C. Have 2 students stand side by side (students #1 and #2).
   D. Another student should lie flat on the floor on his back (student #3).
   E. Two more students should sit Indian-style near the prone student (students #4 and #5). The 5 students should form a semi-circle in front of the class.
   F. The last student volunteer (student #6) is directed to fill the graduated cylinder with 50-ml (1/2 cup) of water.
   G. In front of the class, this student then pours the 50 ml (1/2 cup) of water into a watering can. This student also quickly places three empty 100 ml (1/2 cup) beakers beside the students #3, #4 and #5.
   H. The tablecloth is placed on the body of student #3 and then soil (any type) is lightly sprinkled on top of him. It should be just enough that the other students in the class can see it. (At no time should the head of the student be covered).

Also be sure, nothing is sprinkled near the student's face.

I. The remainder of the class is directed to watch and guess verbally what is happening before their eyes. They may or may not be told that this is a game similar to charades. But the class should be encouraged to verbalize and the teacher should be animated when students respond with correct or incorrect ideas.

J. Student #1 shakes the water can lightly and hands it to student #2 who tips the spout lightly over student #3. Then student #2 pours some water each into the beakers of student #3, #4, and #5. After he empties the water can, he hands the can to student #3 who passes it back to student #1. At this point, students #4, and #5 rise up from their sitting position and pour their beakers of water back into the watering can; the water poured into student #3's beaker is also poured back into the watering can of student #1. Students #1 shakes the can briefly and then passes it on to student #2 and the entire cycle is repeated again.

K. The scenario should be repeated until some students have guessed that this is a representation of the water cycle. Student #1 is depicting condensation, student #2 is depicting precipitation, students #4 and #5 are examples of what happens in transpiration, and student #3 represents the ground where water undergoes infiltration. Along the way, students may have called out precipitation, rain, condensation or evaporation.

L. When the teacher is satisfied that the students have adequately described what is going on, he/she may then still remain silent but encourage students to come up in front of the class and pick up a sign such as evaporation or condensation and to hang it on the student which represented that concept. When all the signs are properly hung up, repeat the scenario before the class one more time. This time the teacher should fully explain what occurs in the model water cycle.

M. Draw the students' attention to the fact that the water was circulated and never lost in the cycle. Ask students to comment on this. What are the implications here with regard to the hydrologic cycle and the earth's supply of water resources?

N. At the end of this activity some of the same questions used in the *Exploration Phase* activity on the Amazon River can be posed to the students again. The teacher should lead the students to appropriate responses at this time.

2. Activity on evaporation.

This activity can be done in one long or two short sessions. The students will discuss and hypothesize what will happen when energy is added to a closed system containing water.

Materials: for each group

- 1 Plastic baggie (zip lock)
- 1/2 cup (125 ml) water for each bag (small paper cups)
- food coloring to put in water (blue or red)
- Three or more different soil types - for example sand or gravel, clay, humus or potting soil. (1/2 cup - 125 ml soil each) Make two sets for a total of six 1/2 cups.

Involve the students in the following activities:

A. Divide the class into groups. You may want to assign roles for the group individuals. (eg. leader, recorder, observer) Assign each group of students to one soil type. Make sure all soil types are used at least once.
B. Put the prepared materials at various places in the room so that students can obtain materials with less classroom congestion.
C. Have students put the soil in a plastic baggie and seal it. Put several drops of food coloring in their cup of water. Carefully pour the water on top of the soil in the baggie. Try not to get the top side of the baggie wet or dirty.
D. Ask the students to predict what might happen if their baggie were left in the sun, or near a heater, or left in their desks overnight.
E. Have them record their predictions and put their baggies in a heated area. If balances are available, students may want to weigh the contents of their baggies before and after they are placed in a heated area.

Note: The lesson can be continued later that day or the next.

F. Later observe and record the contents of the baggie. Drawings should illustrate narrative.
G. Groups should share the results of their observations. Discuss the results found in the various baggies. Questions for discussion:
    1. What has happened to the water?
    2. Where does the water go?
    3. Where does the water come from?
    4. How does the water get from one part of the baggie to the other part?
    5. How can you change the effects observed?

Lead the students to the idea that evaporation is the changing of liquid water into its gas form, to water vapor. We cannot see water vapor. We may feel its affects on our bodies and can measure it as humidity. Condensation is the reverse physical process to evaporation. You can see its results in clouds, fog, dew, frost, and all other forms of precipitation (eg. rain, hail, snow).

3. Activity on transpiration.

To The Teacher: (Evapotranspiration)

On the surface of every leaf of every green plant are thousands of tiny pores called stomates. These play an important role in the life of the plant. Stomates are the openings where gases enter and leave the plant as it carries on its life processes of photosynthesis, absorption, respiration, and transpiration. In addition to the exchange of gases with the air, the plant transpires water vapor through its leaves. It has been estimated that a single corn plant may transpire over 4 liters of waters in a single day. Aquatic plants have most of their stomates on the upper surfaces of their leaves, while most land plants have stomata on their under-surfaces.

Stomates open and close at a rate determined by the amount of water already in the plant. When there is an excess the stomates open to allow some water vapor to escape. When water pressure decreases producing leaf wilting, the stomates close. Oxygen and carbon dioxide can pass through only when the stomates are open, so little photosynthesis can take place when a plant is wilting. Little chlorophyll is produced so leaves turn from green to yellow; the leaf color minus the green chlorophyll. The movement of water through the stomates is essential to the plant's movement of nutrients from the ground into the roots, and up through the stem and leaves.

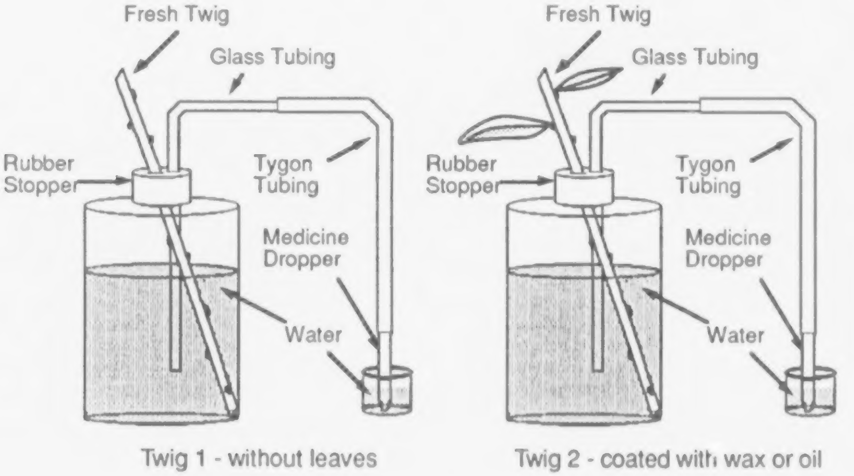
Forest trees, like all other plants, transpire large amounts of water vapor into the atmosphere through their leaves. Forests also retain and utilize considerable quantities of rain or snow water and permit it to be evaporated back into the atmosphere before the water ever deeply infiltrates the soil. By removing a part of the forest cover, more water will strike the soil and less water per acre will be transpired. More surface runoff and infiltration will occur. Although evaporation from the soil might be increased by the cutting, the net result is less water loss to the area. Clearcutting (total harvesting) hardwoods in the Eastern United States results in about two-thirds less water loss by evapotranspiration than on uncut forests.

Note: Do activity as a demonstration. Have students prepare and set up materials under your guidance. If enough equipment is available have groups of students perform as an investigation.

Materials: for a demonstration
- 3 or more very fresh tree twigs (30 cm - 1 ft long, 7 mm - 1/4 in. diameter) with leaves
- 2 250 ml (1 cup) wash bottles or glass bottles with a small neck.
- 2 two-holed rubber stoppers to fit the wash bottles. Clay could substitute for the rubber stoppers.
- L- shaped piece of glass tubing (10 cm - 4 in. long) with appropriate diameter. Clear plastic straws could substitute for the tubing.
- 2 pieces of clear plastic tubing (10 cm - 4 in. long) to fit over glass tubing from each wash bottle (aquarium tubing)
- medicine dropper glass tube. Take off the rubber bulb.
- water
- paraffin wax or cooking oil
- glycerin or petroleum jelly
- an electric hot plate
- small watercolor brush
- a watch
- Figure 2 as a transparency or as a drawing on the blackboard.

A. See Figure 2. Fill 2 250-ml wash bottles three-fourths full of water.
B. Fit each wash bottle with a two-hole rubber stopper and insert a twig and an L-shaped glass tube. [Caution - use glycerin and a towel when inserting. Do not let students do this.]

C. Fit the glass tubing with a piece of clear plastic tubing no more than 1 foot long.
D. In the end of the clear plastic tubing insert a medicine dropper or capillary tube.
E. Place the end of the medicine dropper into a small beaker or cup of water.
F. Make sure all joints are sealed with glycerin or petroleum jelly.
G. Introduce a drop of water into the end of the medicine droppers.
H. Measure and record in a table the distance each water drop moves in 3 minutes for twigs 1 and 2. This distance is a measure of the amount of water that has been removed from the bottle and passed through the plant. (Graph distance versus time)
I. Remove part of the leaves from twig 1. Check movement rate.
J. Remove all leaves from twig 1. Again check movement rate.
K. Coat leaves of twig 2 with wax or cooking oil. Check the water drop movement rate. What happens to the rate of movement?
L. Replace the twig with a new one. Place a plastic bag with a rubber band over the twig. Repeat the above experiment. Does the rate of the water drop movement change?
M. *Optional: Use other species of twigs and compare rates of drop movement..*



Twig 1 - without leaves   Twig 2 - coated with wax or oil

FIGURE 2
SET UP FOR TRANSPIRATION ACTIVITY

N. Discuss the results found with the twigs . Questions for discussion:
  1. What is happening to the water?
  2. Where does the water go?
  3. What affects the rate of water movement?

O. Review the sand-weighing activity and the measurement of a plastic wrapped potted plant from the *Exploration Phase.*

Note: The sand activity demonstrated evaporation and the potted plant activity demonstrated transpiration. A drop of water can change unendingly from one state to another given the right conditions.

4. *Optional : Activity on capillary movement.*
   Use this demonstration as a way to tie together what happens inside of a twig, tree, or plants in general.

Materials: *For a demonstration*
- Fresh cut celery stalks with leaves--2 slender stalks, 2 thicker stalks
- food coloring
- water
- 2 50-ml (1/4 cup) beakers.

- *A. Mix water and food coloring. Place 1 slender stalk of celery in a beaker. Place the thick stalk in a second beaker. Observe, time, and record the events. Do the leaves color at equal rates?*
- *B. Use hot water in the beakers and fresh celery stalks. What happens? Time the events again.*

5. Discuss the results of the *Inventing the Idea Phase* activities in terms of forest, soil and water examples. Begin with the following questions:
   - A. What is happening to the water? Lead the students to the understanding that water is moving through the forest and soil system in a regular pattern. The variables of evaporation include the soil type.
   - B. Where does the water go? Lead the students to the understanding that evaporation and condensation occur in a cyclical process. Transpiration is the name of the process by which water evaporates from leaves. The variables influencing the amount of transpiration are leaf surface areas, temperature, leaf surface type, species of plant, humidity, air movement, etc.
   - C. Where does the water come from? Lead the students to the understanding that ground water absorbed by the tree roots is the result of precipitation, a part of the complete water cycle.
   - D. How are plants involved in the earth's water cycle?
   - E. Do you suppose all trees transpire at the same rate?
   - F. Introduce the concept of evapotranspiration as a major feature of the earth's water cycle.

6. Closure - Review the concept of evapotranspiration, and the water cycle thoroughly. Show the transparency, Figure 1, on the water cycle and have students discuss and reflect upon the following questions;
   1. Once having fallen to the earth, where can water go?
   2. How does surface water get back into the air? (evaporation, evapotranspiration, and runoff to the ocean)
   3. What things in the environment affect the water cycle rate? (climate, soil type, vegetation type, amount of runoff)

EXPANDING THE IDEA PHASE

TO THE TEACHER:

In the final learning cycle phase the student must use and apply facts, concepts, and relationships concerning the water cycle. Students should refer to cumulative information, notes, fact sheets, etc. New contexts and different ways of looking at the ideas explained in the earlier part of the lesson should now be attempted. Following the *Expanding The Idea Phase*, the teacher should check student outcomes with a quiz; performance test, and/or discussion.

EARLY CHILDHOOD ACTIVITIES

Note: Instruct students to save notes, drawings, and charts in a notebook for future reference.

Materials: for the class
- colored construction paper and magic markers
- paste, paste sticks
- scissors
- flat world map

Involve the students in the following activities:

1. To illustrate the concept of a water cycle, have the class construct paper chains. Each link of the chain will be tagged with a part of the water cycle. The chains will be connected forming a continuous chain with no beginning or end. Have the students explain how the water cycle is like the continuous chain.

2A. Using a flat world map help students locate bodies of water and ask:
  - "Will the world ever run out of water?" (Fresh water availability is a problem today.)
  - "Is there something we can substitute for water?" (NO!)
  - "Can we drink any water we want to?"
  - "What is water used for by our families?"
  - "Where does water go after we use it?"
  - "What happens to the moisture on our skin when we sweat?"

or

B. Crush various kinds of fruit/vegetables for the class to see what comes out. Ask the class about, "What comes out of the fruit or vegetable when crushed?" "How does the fruit or vegetable get moisture?" "Do animals use water?" "Is water necessary for life?"

or

C. Show pictures/slides of a desert and contrast with pictures/slides of rain forests and ask, "What makes them so different?"

MIDDLE CHILDHOOD ACTIVITIES

Materials: for each student
- Student Handout #3
- drawing paper
- pens, colored markers
- chart paper
- world map

Involve the students in some of the following activities:

1. Using Student Handout 3 ask the students to describe the stages of the hydrologic cycle and fill in the terms for parts of the water cycle in the appropriate spaces. The words do not have to be exact.

2. *Optional: Assign outside readings to the students for in class discussion. One comprehensive and interesting article is in by Thomas Y. Canby entitled "Water, Our Most Precious Resource" in National Geographic, August 1980, Volume 158, No. 2, p. 144.*

3. Discuss several of the following questions:
   A. What are some control measures that can be taken to prevent runoff, evaporation from the soil surface, and transpiration?
   B. How would pollution affect transpiration? Smoke from industry, trucks and burning of trash will coat plant leaves with small soot particles (particulate pollution) and interfere with their life processes. Where might this be happening? Where locally?
   C. Home Assignment - Examine and collect leaves from at least 3 locations, such as near a road, near a factory, near a house or in a wooded area. Have the students discuss how these results would affect transpiration.
   D. If all plants died at once, what would happen to the water cycle? (The water cycle rate would slow down since one important part is missing.)

4. *Students may wish to construct and design a variety of dynamic closed systems--for example a terrarium, aquarium, space station or future closed city. One real-life example of this is Biosphere II, and articles for further information on it include:*
   - *Reingold, E.M., "Noah's ark - the sequel: to test ideas for outposts on other planets, scientists have built a replica of the earth in the Arizona desert." Time, 24 September 1990, p. 72.*
   - *Ansley, D., "The new world." Discover, September 1990, p. 60.*

5. From the simple experiments in this module, students can draw inferences and analogies concerning the water cycle and the variables that affect it. Summarizing concepts and addressing specific questions listed below will

help the students to bring the investigation results together.

Concepts

1. Condensation	6. Groundwater
2. Evaporation	7. Transpiration
3. Precipitation	8. Water cycle or hydrologic cycle
4. Capillary movement of soil water	9. Water cycle and plants
5. Runoff	10. Water as a natural resource

Questions

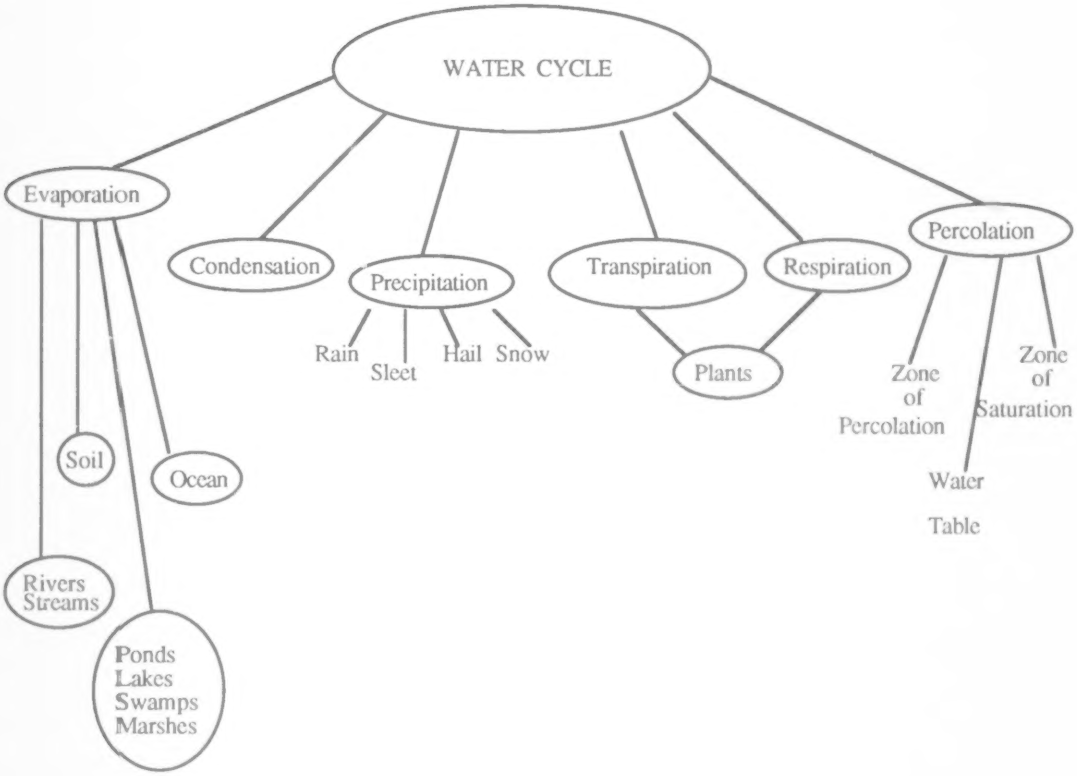
A. How does the exchange of water between the earth and the air take place? What is this exchange of water called?

B. Is it possible to change the hydrologic cycle in a way that would benefit people?

FINAL EVALUATION

The teacher may wish to culminate with an additional application/inquiry/problem evaluation of lab reports and drawings. For example, students can report on methods of increasing water resources such as cloud seeding and desalinization or report on the methods of conservation of water resources. Early childhood students can draw, paste pictures, cut paper shapes, or paint pictures of the concepts of evaporation, condensation, and precipitation.

WATER CYCLE CONCEPT MAP


WATER CYCLE
Evaporation
Condensation
Precipitation
Transpiration
Respiration
Percolation
Rain
Sleet
Hail
Snow
Plants
Zone of Percolation
Zone of Saturation
Water Table
Soil
Ocean
Rivers Streams
Ponds Lakes Swamps Marshes

STUDENT HANDOUT 1

Looking at Wet and Dry Areas

Area Location:____

____

DAY	*VERY WET*	*WET*	*DRY*	*VERY DRY*
1.				
2.				
3.				
4.				

STUDENT HANDOUT 2

Making Observations of Ice Melting

An Exploration Activity:

Observation of Ice Cubes Set Up on Different Materials

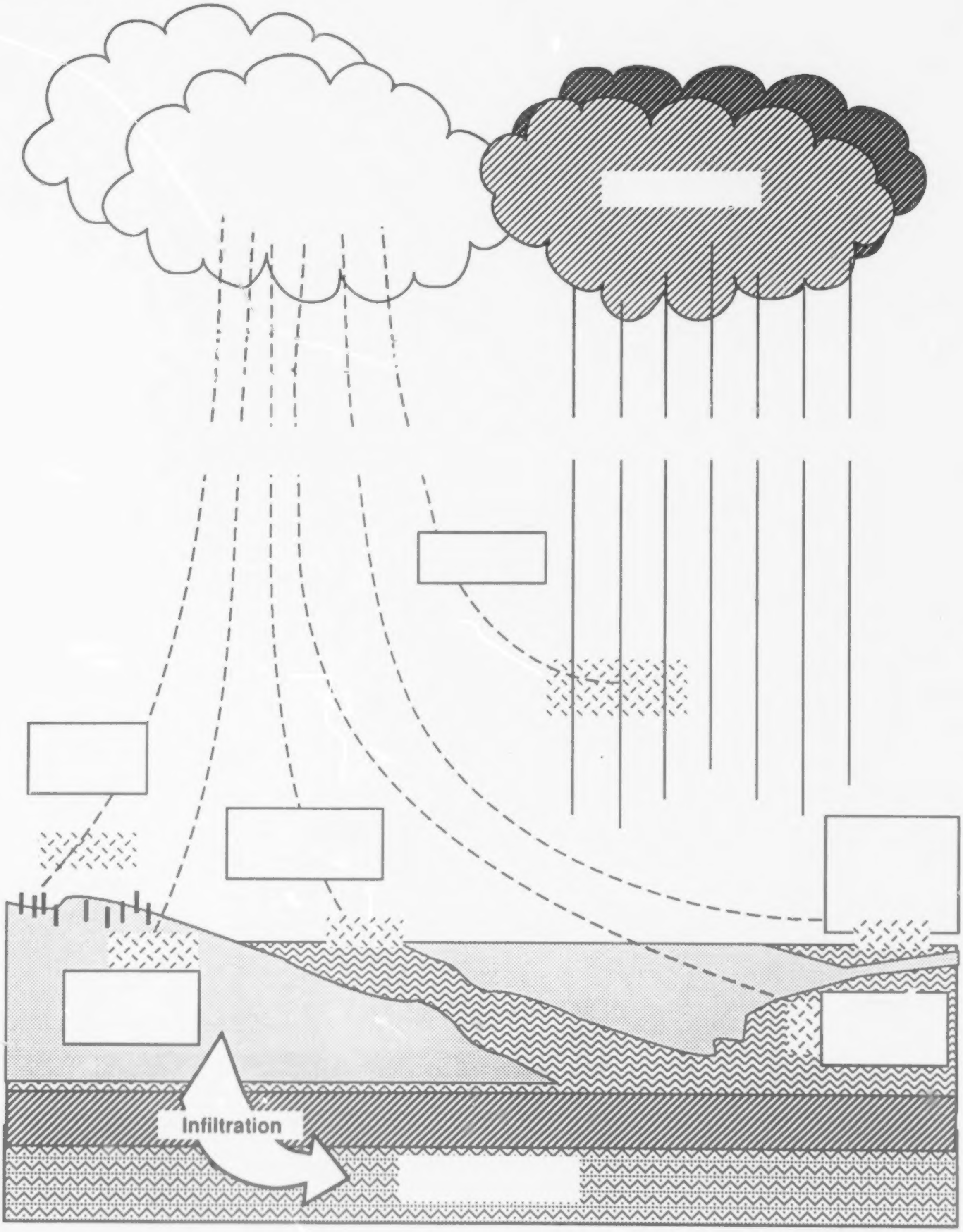
students may also draw what they observe on separate paper, and write their observations (e.g. very wet, wet, dry, very dry, etc.)

Day 1

Time	*Plate*	*Sponge*	*Flower Pot*	*Paper*	*Jar*
10 minutes					
20 minutes					
30 minutes					

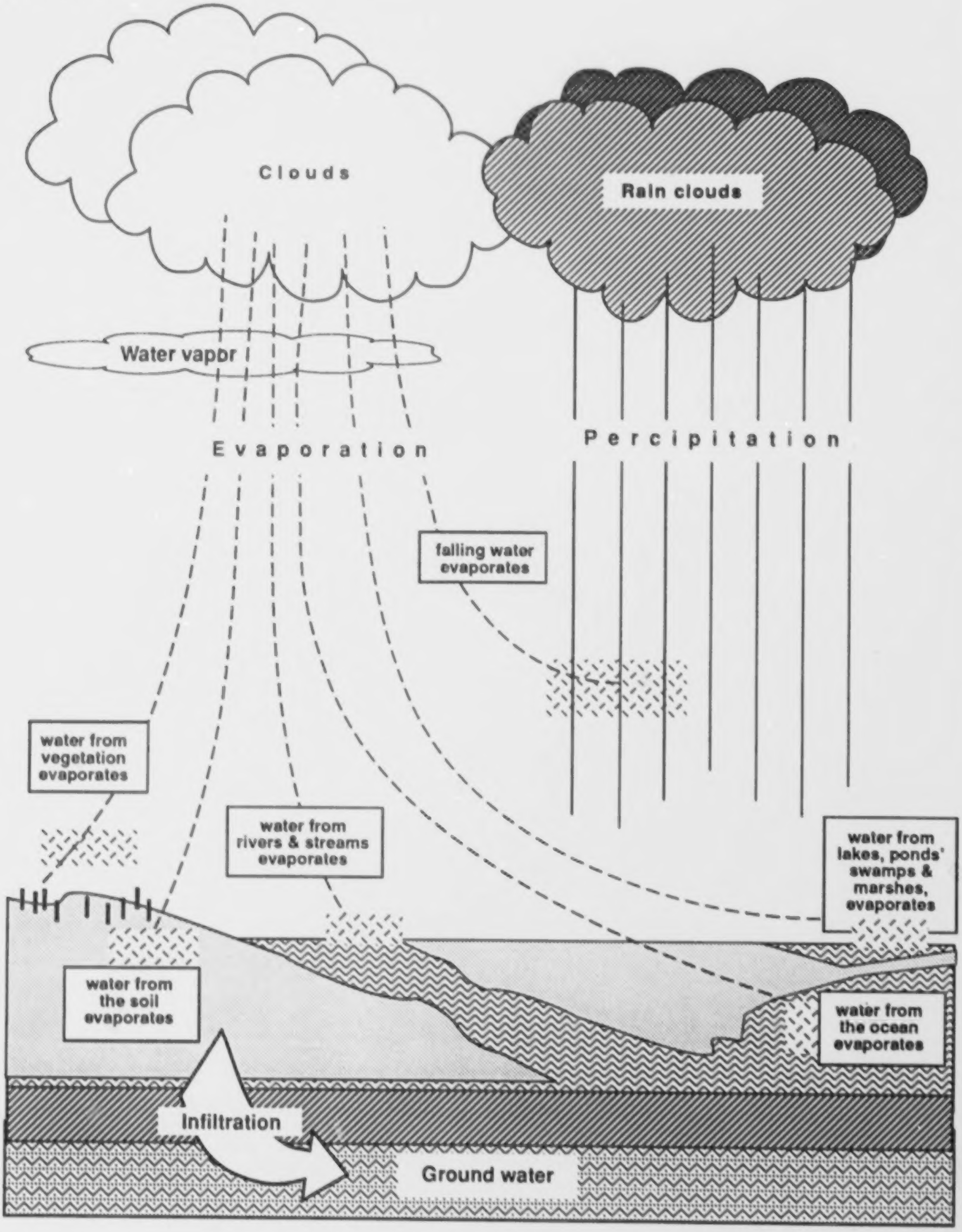
STUDENT HANDOUT 3

The Water Cycle


Infiltration

STUDENT HANDOUT 3
TEACHER GUIDE

The Water Cycle


Clouds
Rain clouds
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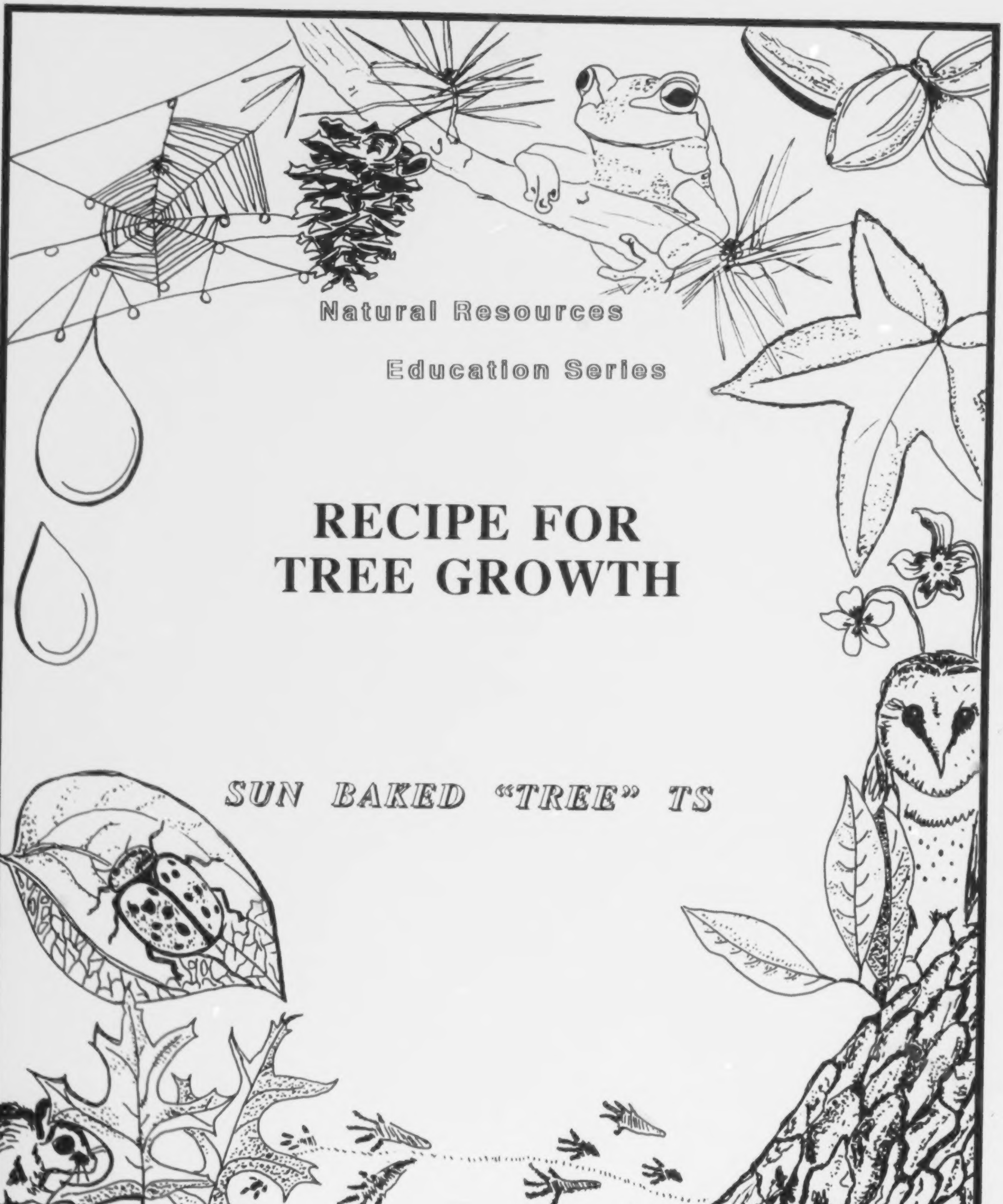

Natural Resources

Education Series

RECIPE FOR TREE GROWTH

SUN BAKED "TREE" TS

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The writing, development and, production of the ***NATURAL RESOURCES EDUCATION SERIES*** is a joint project with collaboration of project directors Dennis W. Sunal, The University of Alabama, and Mary E. Haas, West Virginia University, and the U.S. Forest Service. Partial funding was provided by the U.S.D.A. Forest Service. The initial author and series editor was Dennis W. Sunal. Revision of individual modules was carried out with the help of Mary E. Haas, and Cynthia S. Sunal. Assistance in creating appropriate activities, proof reading, and creating art work by computer for the many editions was provided by Jon Berninzoni, Elwin Dickerson, Tracy Johnson, Jane McGinnis, and Sukhwindar Singh. Final editing assistance on the text and artwork was performed by Audrey Rule. William Kline, Jr. assisted in training the original trial teachers. Content reviewers were specialists in the various module topics at the U.S. Forest Service including Monongahela National Forest staff members, Theresa Anne, Randolph Harrison, Linton Wright, and Harry Mohoney, and Northeastern Forest Experiment Station, Timber and Watershed Laboratory staff Pamela Edwards, David Helvey, James Kochendorfer, and Clay Smith. Teachers in the Randolph County, West Virginia Schools who first taught the modules and made recommendations for revisions were: Sandra Arbogast, Sara Basil, Ann Deloach, Karen Hall, Richard Leitner, Elizabeth McDonald, Linda Moore, Sharon Moss, Pam Mullennex, Jeff Ranhart, Theresa Skidmore, Rachel Snavely, Charles Swecker, Nancy Taylor, Angela Vance and Rebecca Wallace.

The ***NATURAL RESOURCES EDUCATION SERIES*** is designed to supplement textbooks with active learning lessons for students in the primary and middle childhood grades (K-8). The series consists of Understanding Our natural Resources Teacher's Guide and 12 Modules including Appreciation of Natural Beauty, Soils and Plant Growth, The Water Cycle, Natural History of a Tree, Recipe for Tree Growth, Tree Growth and Environment, Forest Processes, Managing Our Forest Resources, Growth of a Forest, Interactions of Forest Plants and Animals, Natural Watersheds, and Managing Our Natural Resources.

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SUN BAKED "TREE" TS

RECIPE FOR TREE GROWTH

SUN BAKED "TREE"TS

BACKGROUND INFORMATION FOR TEACHERS

This module would complement textbook and teacher prepared units relating to factors effecting plants, plant growth, activities and responses of plants. The module investigates the basic "ingredients" of tree (plant) growth; water, minerals, and light. The two to four lesson module is to be supplemented by 15 days of brief student observations, 5 to 10 minutes each day. The first middle childhood level activity must be prepared in advance Bean seedlings with leaves present (10-12 days old), tree seedlings, or other young plants will be needed.

Biologists are able to describe the growth and development of a plant in some detail and know much about the influence of various "ingredients" on growth. Definitions of growth always involves size and weight, so growth is most often measured by an increase in one of these variables. The growth of a tree, as with all plants, follows an s-shaped curve: growing rapidly initially, reaching a limit, then tapering off.

It is common for students to describe the minerals (or more commonly nutrients) taken in by tree roots as food. The cause of this misconception stems from everyday language and TV commercials which equate food and fertilizer. Food is defined as an energy containing substance. Substances such as minerals, water, or carbon dioxide taken in by plants do not fulfill this definition of food. All food used by a tree (plant) is created in the tree. Trees use this food in their cells as a source of building material and energy. Food is used for raw materials in building new cell walls, protoplasm, cell organelles, etc. Food is also used in respiration, providing the energy used in growth processes.

Food for a tree is actually composed of complex carbohydrates, for example starch. These carbohydrates are made in trees through the combination of minerals and water brought in through the roots, and carbon dioxide, a constituent of air, taken in through small holes in the leaves. This food making process requires the chemical chlorophyll, the green matter in plants, and energy received from sunlight.

Water is used in making protoplasm and cell walls and in transporting minerals, carbohydrates, and other substances throughout the plant. Water also provides pressure in the cells to keep them, and the plant, from collapsing.

Tree (plant) functions are influenced by light, air, water and nutrients. Growth of the various parts of a tree is generally coordinated with the availability of these "ingredients." Variations in light, air, water, and nutrients correlate with tree regeneration, dormancy, growth, and periodic changes.

OBJECTIVES: **Choose those appropriate for your students.**

-Make and record observations of growth.

-Identify light, water, air and nutrient influences on tree processes such as seed germination, growth rates, pigment production, and plant health.

-Compare and contrast healthy plant specimens with unhealthy ones.

-Create graphs, timelines and illustrations analyzing growth data.

-Identify variables and products of energy use in trees.

EXPLORATION PHASE

TO THE TEACHER:

The initial phase of exploration involves interactive activities using observation and other science process skills to help students, on their own, discover basic concepts and relationships in tree growth. The teacher should use this time to organize groups, observe interactions and permit students to investigate possibilities themselves. Students should be asking questions, gathering first hand information and making connections to their previous experience in and out of school. Ideally the student should be confronted with a problem or event which cannot be explained by past knowledge.

EARLY CHILDHOOD ACTIVITIES

Materials: for a demonstration

Chef's Props

- recipe book
- chef hat (can be made from paper)
- packages of ingredients labeled heat, air, nutrients (in soil), water, seeds
- large mixing bowl and spoon

or

Magician's Props

- simple magic tricks that are obvious or that purposefully fail
- magician's hat and wand
- prop with ingredient decorated with "sparkles"

Other materials for the class:

- 50 - 100 seeds, various kinds of vegetables
- 2 - 5 tree seedlings
- illustrations of plants and trees from magazines or catalogs for comparison
- chart paper for classification of seeds/class and individual charts
- paper cut representations of ingredients for further discussions of depravation effects
- soil for students to plant their own seeds
- plant pots and a tray for watering

Involve students in the following activities:

Day 1

1. Teacher portrays a chef (Chef "Boy-Are-Tree") following a recipe to make something special. (As an alternative this could be performed as a magician.)

2. Use "self-talk" while involved in activity:

   - "I think I'll make something special for you today!"

   - "I'll need some beams/rays of light". Get packages labeled heat and prepare to read instructions on side "can be warm at times, hot at times," "caution too much may cause harm. Animals, humans, plants and trees need certain amounts to stay healthy to grow." Pour some in[illegible]ixing bowl or measuring cup.

3. Follow a similar pattern as the remaining ingredients are added to the mixture.

4. Elicit responses from students as to what the special treat is going to be.
   - add seeds last!!

5. After measuring and mixing ingredients, tell students that the recipe calls for waiting several days before disturbing the mix and before they see what Chef "Boy-Are-Tree" has made!

Day 2

6. Ask students to pretend that several days have passed. Put several seedlings in a bowl to show students what became of all those ingredients.

7. Review ingredients. Ask what would happen if Mom or Dad left out an ingredient when making cookies, cake, or anything.

8. Gather various kinds of seeds, both vegetable and tree seeds. Give seeds to students and let them handle them. Suggest making piles of the same kinds of seeds. Inquire about their classification qualities. Students can list characteristics or make charts or graphs. They could make a bar graph for size, shape or color.

9. Ask students to describe the observable differences of vegetable and tree seeds.

10. Ask students to describe the observable differences of vegetable plants and trees by looking through magazines and gardening catalogs for examples of various trees and plants.

TO THE TEACHER:

Students will work in small groups of 5 - 7 initially for the *Exploration Phase.* Thereafter, the focus will be whole group and paired lab partners. Most activities following the exploration will require close teacher monitoring and guidance. At the conclusion of this module students will discuss and report findings in models, graphs, tables, illustrations, reports, and/or demonstrations.

The degree of intensity of light has a great effect on plants. Intensity of sunlight plays a large role in determining which species of tree will grow well in a locality. Greater intensity of light causes a greater rate of food production, starch, through increased photosynthesis. However, plants grow more rapidly in length under light of decreased intensity. This growth leads to tall spindly plants. If you are aware of how intense the light must be for various kinds of tree to flourish, you may avoid failure when you attempt to grow them.

Chlorophyll is found in plant cells in many small discrete bodies called chloroplasts. Chloroplasts vary in size, shape and color. They can be seen in green tree cells with a small microscope, and usually appear as small green ovals inside the plant cell.

Preparation for this activity should include germinating seeds in small pots 10 to 12 days (for saplings, 2 plants per pot) and another batch 5-6 days(for seedlings, 3 plants per pot) before the lesson starts. Students can help in this preparation activity. See requirements below in *Materials* and Table 1. Perform activity as a whole class experiment.

Materials: for the class

- 60 tree seeds (maple or other trees) or bean seeds (lima, navy), etc.
- 18 potted maple seedlings (leaves are just beginning to form) - starts from nursery, or germinated beans (lima, navy)
- 12 potted saplings (leaves are well formed) or young bean plants (lima, navy)
- 18 plant pots (clear plastic cups or peat pots in a watering tray)
- 3 "hats" for plant pots to block out light
- plant fertilizer (nutrient), a pinch per pot
- sand
- potting soil
- 10 rulers
- 15 hand lenses (magnifying glasses)

Involve the students in the following activities:

1. To introduce the lesson ask students to list the conditions required for the very best trees (plants) to grow. The students should realize that required conditions vary with different species. For example, some trees grow best with a lot of water, others with little.

   Students should brainstorm and list the required conditions on the board (see Table 1 example). From this list the teacher will help students construct a growth investigation chart on which they will record observations of conditions and tree (plant) growth. The students will make and record observations concerning stages of growth of individual seeds, seedlings, and saplings. Each cell on the chart below will represent a plant pot. Label each pot. All plants are placed in potting soil except the "no nutrient", which is placed in sand.

Table 1

Growth Investigation Chart

	Light	Dark	Water	No Water	Nutrients	No Nutrients
SEEDS 10 per pot						
SEEDLINGS 3 per pot						
SAPLINGS 2 per pot						

2. Ask students to:
   A. observe daily and record characteristics of growth in the tray cells for 10 - 15 days.
   B. list all observations for each day in a journal notebook. Include measurements of growth (height of plant from tip to soil and number of leaves).
   C. compare the distance between leaves or branches on plants grown in the dark to that of plants grown in the light.
   D. summarize the chart growth conditions in small groups. Students will then move to large groups to further discuss findings, hypotheses, and predictions.

3. Students may conclude that,
   A. Seeds will not grow without an appropriate amount of
      1) light,
      * 2) water, and/or
      3) nutrients.
   B. Seedlings will not grow without an appropriate amount of
      * 1) light,
      * 2) water and/or,
      3) nutrients.
   C. Saplings will not grow without an appropriate amount of
      * 1) light,
      * 2) water and/or,
      * 3) nutrients.

   * *most important*

4. Students should graph the growth results for each of the categories (A1, A2...) pre-

sented in Activity 3 above. Bar graphs would be appropriate. They should result in nine graphs, each comparing growth with an element (i.e. water) to growth without (i.e. no water).

5. Students may then discuss possible or predicted results and hypothesize about light, water, nutrient and other elements on tree growth.

INVENTING THE IDEA PHASE

TO THE TEACHER:

During this phase of the learning cycle the teacher will play a more directive role. At this time the teacher may wish to refer to notes, background information, etc. The teacher may use student activities to reinforce exploration activities in addition to demonstrating and explaining some of the ideas involved in tree growth. Students who were not able to answer the problems or events given in the *Exploration Phase* should be led to an appropriate response at this time.

EARLY CHILDHOOD ACTIVITIES

Materials:

- 15 - 25 Styrofoam coffee cups or plant pots
- 25 - 30 bean seeds
- Plant fertilizer
- Boxes (shoe or other small containers) for light and air experiments
- Potting soil
- Sand
- 10 rulers
- 15 hand lenses (magnifying glasses)

Involve the students in the following activities:

1. Discuss/ review the ingredients needed for healthy trees and plants.

2. Ask if there is a way that we can be sure that trees/plants really do need light, water, and nutrients. Students may draw, cut and paste or paint pictures of their guesses.

3. If there are no suggestions the teacher should guide the students to a simple experimental approach testing for the variables which affect plant growth: light, water, and nutrients.

4. Assign students to six groups: the light or no light experiment groups, the water or no water groups, and the nutrient and no nutrient groups. For the non-nutrient group, use sand for the soil; use potting soil for the other groups.
5. Entertain hypotheses about the effects of the presence or absence of the various

factors or the over abundance of some factor. Observe and record the results through daily writing or drawing, over a 10 - 15 day period. A simplified and more teacher guided version of the *Middle Childhood Exploration* activity would be appropriate.

6. Provide a closure to the *Invention Phase* by briefly stating in the student's level of language that tree (plant) functions are influenced by light, air, water and nutrients. Growth of the various parts of a tree is generally coordinated with the availability of these "growth ingredients".

MIDDLE CHILDHOOD ACTIVITIES

Materials: for the class

- Optional activity: Film: "How a Tree Grows" - U.S. Department of Agriculture - Forest Service Film
or "A Tree is Born" - U.S. Department of Agriculture - Forest Service Film

Note: *The above film titles, among others, may be obtained free of charge by contacting your local U.S. Department of Agriculture office.*

Involve the students in the following activities:

Note: This should occur after observations have been made during the *Exploration Phase.*

1. Review the results from the *Exploration Phase* activity.

    A. List and discuss factors in growth using a chart to list variables. Summarize results for the students.

    B. List and discuss other factors which might be considered. One idea that should be taken into account is time. For example, does the rate of increase in the intensity of light matter? What about increasing the number of hours of sunlight?

    C. Ask students to describe experiments that would support their own hypotheses about air, water, nutrients, light and other factors. Students might want to do their experiment as a project separate from this lesson. Discuss with the students possible predicted results. Examples include:
        1. Trees (plants) will germinate without light.
        2. Trees (plants) will not grow without water.
        3. Trees (plants) grow optimally only with the appropriate amount of nutrients.

Students may illustrate, chart or describe predicted results.

2. *Optional: Show a film or videotape which summarizes tree growth. Discuss concepts brought out in it relating to trees and what seems to effect their growth.*
3. Activity to investigate the effects of light on tree (plant) growth.

Materials: for the class
- 6 tree (or bean) seedlings at least 10 days to 2 weeks old or tree leaves from outside trees
- hand lenses (magnifying glasses) for each student
- *graph paper (optional)*
- *5 - 10 microscopes (optional)*
- *20 microscope slides and cover slits (optional)*
- *razor blade (optional) Note: This should be handled by the teacher only.*

Note: Put one or more tree or bean seedlings in a dark place away from sun, and one or more grown in light for 10 - 15 days before the activity begins . You could use the plants from the *Exploration Phase.* Also effective would be to place folded construction paper over a mature leaf on an outside tree for the same time period. It would be best if each group or team of students working together in science activities do this themselves. The seedlings could be grown in a box with a hole in it.

A. Using the hypotheses suggested in 1.C. above, form groups and focus on one which relates changes in tree leaves to changes in light intensity.

B. Give each student leaves from the seedling samples grown with and without light and a hand lens. Ask the students to explore the seedling leaves. If needed, ask the students to observe shape, surface and edges of all parts of the seedling.

Note: The students will see coloration variations between the seedlings used (a different intensity of green in a single leaf).

C. *Optional: If available, with a microscope examine cross sections of leaf seedlings grown in light and dark. The teacher should prepare a slide of a thin cross section of the leaf. Prepared slides are also available from scientific supply companies. Compare the two seedling types above for number of green bodies (chloroplasts) and the size and shape of cells.*

D. Plants often grow too tall and spindly and vary in color when they are raised indoors with little light. After completing the activities above, pose the following questions to the students.

   1. What did you observe in the plants? Make a list with 2 columns: tree (plant) in light, and tree (plant) in dark.
   2. What observations were different in the 2 types of plants?

3. What was the cause of the difference?
4. What could you do to change this type of growth?
5. How does rapid growth help a plant in the dark?
6. Where might this type of growth occur in the forest?
7. How does the distance between leaves compare on the plants grown in light and dark?

Note: The rapid growth of plants that occurs when they are illuminated by very low intensity light is known as etiolation. There is a relationship between the size and shape of plant cells and the number of chloroplasts and level of light intensity. Cells become elongated, cell walls thinner and the plant is less sturdy.

4. *Optional: Review questions and discussion for either panels or groups. Find out and decide with a library excursion.*
   - *What stimulates bud growth in the spring?*
   - *What initiates as well as stops tree (plant) dormancy?*
   - *How are seed dormancies broken? What starts a seed into its growth stage?*
   - *At what period during growth is growth occurring at the most rapid rate?*
   - *Are tree growth rates steady? Why or Why not?*
   - *What are some general patterns of growth (periodicity)?*

5. Provide a closure to the *Invention Phase* by briefly defining the idea that tree (plant) functions are influenced by light, air, water and nutrients and illustrating with the experiences above. Growth of the various parts of a tree is generally coordinated with the availability of these "growth ingredients". Variations in light, air, water, and nutrients correlate with tree regeneration, dormancy, growth, and periodic changes.

EXPANDING THE IDEA PHASE

In the final learning cycle phase the student must use and apply fact, concepts and relationships concerning tree growth. Students should refer to cumulative information notes, fact sheets, etc. New contexts and different ways of looking at the ideas explained in the earlier part of the lesson should now be attempted. Following *Expanding the Idea Phase*, the teacher should check students' outcomes with a quiz, performance test and/or discussion.

EARLY CHILDHOOD ACTIVITIES

Materials:
- 20 - 25 Styrofoam cups
- 60 - 75 seeds
- potting soil

1. Introduce the students to Student Handout 1, Plants and Buildings Activity. Take the class on a school grounds field trip. During the field have the students complete, or

simply discuss questions on, the Handout. Back in the classroom discuss results from the completed Handout. Discuss with the students how important "growth ingredients" (amounts of water, light, and nutrients available) effect tree (plant) growth.

2. *Optional: With a large illustration (slide, picture or blackboard) of a forest ask groups of students how water, light, and nutrients vary in different parts - near the edge, center, low to ground, high up in the branches, on the top of a hill, in a valley, etc. For each location ask students to describe and or illustrate the type of tree growth expected. Each group should develop their own specific situation.*

3. *Optional: Ask the groups of students to describe the effect of one particular growth element (light, no water, etc.) on a tree. Each child should draw how this element could be tested. Give each child a styrofoam cup, soil and 3 seeds to try at home. Send a note home to involve parents in the activity. Students should report periodically and summarize results after about 2 to 3 weeks.*

MIDDLE CHILDHOOD ACTIVITIES

TO THE TEACHER:

Students should keep a notebook on data and recordings. The culmination may end with presentation of reports from the experiments. Reports may be done in group fashion in which students are assigned various tasks such as graphing, written report, and graphic representations. This activity may culminate with a film showing.

Materials:
- tape measure or yard/meter sticks
- stakes
- hammer
- string
- writing materials

1. Choose a section of the school grounds where a grass field borders on a grove/stand of trees.

    A. Lay out a line (transect) about 10 meters (30 feet) long starting under the trees and ending in the field. Count and record the type and number of plants found under each 1/2 meter (1 1/2 feet) of the string. Chart or plot the results. Relate the results to varying "growth ingredients" - light, soil conditions (nutrients), and water.

or

    B. Lay out 3 to 6 areas, 1 square meter (1 yard) each (a quadrat) along the border separating trees or bushes and a grassy field. There should be definite differences in the amount of light each area receives. Count and record the type and number of plants found in each area. Tape a piece of plant to the paper if its name is not known. Chart or plot the results. Relate the results to the varying light conditions in each area. Each student group should work with one area. Students can compare and discuss results in a whole group setting. Connect to the idea that growth of the various parts of a tree, or various tree types, is generally coordinated with the availability of these "growth ingredients".

2. Create problems for students relating "growth ingredients" to plant growth. Ask the students to attempt solutions using the ideas gained in the previous activities.

   - Home owners and park planners sometimes unsuccessfully try to grow grass lawns in specific areas of a lot or park.
   - What are possible causes of the problem?
   - How could you help solve the problem?
   - How might this problem affect you?

3. Introduce the students to Student Handout 1, Plants and Buildings Activity. Carry out a class field trip on the school grounds. During the field have the students complete the Handout. Back in the classroom discuss results from the completed Handout. Discuss with the students how important "growth ingredients" (amounts of water, light, and nutrients available) effect tree (plant) growth.

FINAL EVALUATION

The teacher can make ongoing evaluations and include a quiz involving matching of variations in available “growth ingredients” to predicted tree (plant) growth. Student reports and research projects also can serve as evaluative components. The teacher may incorporate notebook drawings and graphs of plants as well as reports for final, portfolio, evaluation.

STUDENT HANDOUT 1

Plants and Buildings

FACTS FOR THIS LESSON

Some plants - trees, shrubs, grass, and flowers - grow well close to a building. The building provides shade in some places. Buildings also protect plants from wind. Buildings can give off heat. Their roofs shed water which falls onto and soaks into the soil.

WHAT TO DO

Go on a field trip with your teacher and look at the plants around your school building.

ANSWER THESE QUESTIONS:

On which side of the building do the plants grow tallest?

____

____

Can you find a place where there are lots of small plants growing?____________

If so, where is the place?____________________________

Can you find moss growing anywhere around the building?____________

If so, on which side is it growing?________________________

Is there a place around the building where there are no plants, or very few plants?

____

If so, why do you think plants do not grow well here?____________

____

What other differences can you find in plants (number, type) on different sides of the building?____________________________

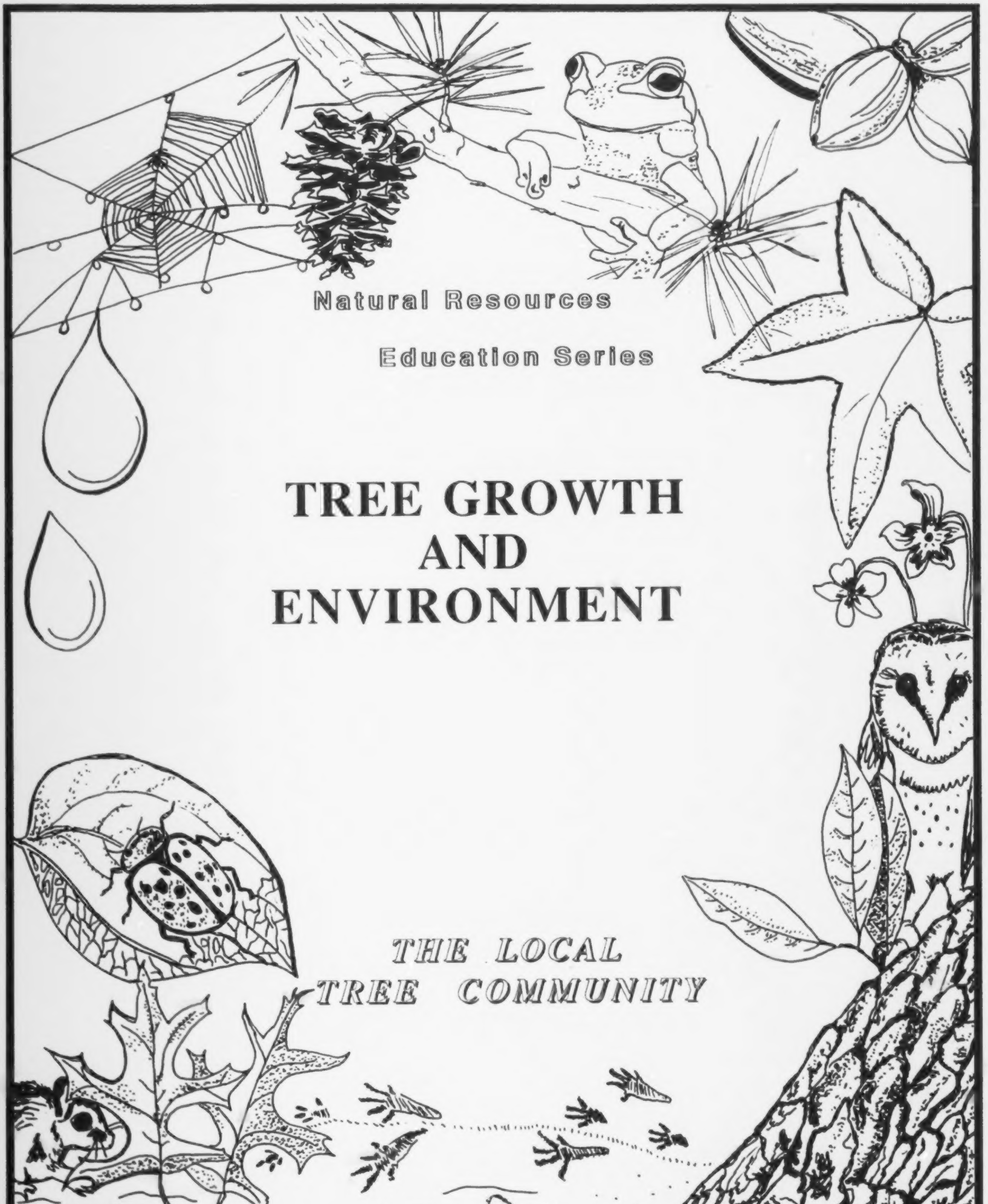
____

____

Natural Resources

Education Series

TREE GROWTH AND ENVIRONMENT



THE LOCAL TREE COMMUNITY

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The *NATURAL RESOURCES EDUCATION SERIES* is designed to supplement textbooks with active learning lessons for students in the primary and middle childhood grades (K-8). The series consists of Understanding Our natural Resources Teacher's Guide and 12 Modules including Appreciation of Natural Beauty, Soils and Plant Growth, The Water Cycle, Natural History of a Tree, Recipe for Tree Growth, Tree Growth and Environment, Forest Processes, Managing Our Forest Resources, Growth of a Forest, Interactions of Forest Plants and Animals, Natural Watersheds, and Managing Our Natural Resources.

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TREE GROWTH AND ENVIRONMENT

TREE GROWTH AND ENVIRONMENT

THE LOCAL TREE COMMUNITY

BACKGROUND INFORMATION FOR TEACHERS

This module would be appropriate with science textbook and teacher prepared units relating to factors effecting plants, plant growth, environment and ecology. The module will focus on identifying features of the environment which influence tree (plant) growth. This influence results from changes in the amount of water, light, and nutrients a tree receives or is able use.

The concepts of climate and weather help us describe the overall environment of a tree. The "macroenvironment" is the environment which is influenced by the general climate and latitude of a region. Long term summaries of weather report data on rainfall, wind speed, and temperature are measures of the macroenvironment. The macroenvironment of trees has a marked influence on their growth. After securing plants of the best possible heredity, the next best component in successful cultivation of trees involves providing them with the best possible "macroenvironment".

The "microenvironment" of a tree can be described as consisting of all the other organisms that in any way effect the tree (biological environment) and of the various substances and types of energy that the tree is exposed to (its physical environment). Microenvironment effects are usually short term effects. The growth of a vine over a tree is one type of social interaction of the microenvironment. Trees of a forest interact socially with the smaller plants of a forest primarily by altering their physical environment. They reduce the light intensity and temperature, increase the humidity of the air, and add organic matter to the soil as their leaves fall and decay. Soil type, exposure, and position of trees on a hillside are also parts of the physical environment. The microenvironment can effect differences in tree growth.

OBJECTIVES: Choose those appropriate for your students.

-Identify parts of the (micro) environment which influence tree growth.

-Compare and contrast effects of environment on tree growth.

-Predict types of tree growth in specific environments.

EXPLORATION PHASE

TO THE TEACHER:

Beginning the lesson with *Exploration* involves interactive activities using observation and other science process skills. These activities help students, on their own, to discover basic concepts and relationships between the (micro) environment and tree growth. The teacher should use this time to organize groups, observe interactions and permit students to investigate possibilities themselves. Students should be asking questions, gathering first-hand information and making connections to their previous experiences in and out of school. Ideally the student should be confronted with a problem or event which cannot be explained by past knowledge. Students may work in pairs for the exploration phase and individually and in larger groups during the rest of the lesson. Students will list and observe factors of the environment and growth from photos, graphs, and descriptions.

EARLY CHILDHOOD ACTIVITIES

Materials: for each student

- notebook paper
- pencils
- two or three paper bags for each of the activities below.
- maps for activity one below (as needed)
- Student Handout 1

Involve the students in one of the following activities:

1. Students may do a sampling of a limited area. Students may go outside to visit an area where there is just one tree, visit an area with a few trees, or visit an area where a field or lawn grows into a stand of trees. In the area visited, students should move towards the tree(s) watching their feet and the area around them as they walk. At designated intervals, the teacher should ask them to stop and record what they see around their feet. They can record these as: "far away from the tree(s)", "getting closer to the tree(s)", and "very close to the tree(s)." If one tree is used, students can be given a map with a drawing of a tree in the center and three concentric circles around it, designating each area from far away to very close. Provide copies of Student Handout 1 to students. If the students have been walking through grass, for example, they should note that, as they reach the area under the tree, usually in its shade, the grass gets sparse or other plant species are dominant. Students may collect samples of the common plants found in each of the three locations.

or

2. A. Take a brief walking field trip, 15 minutes, in an area which has a stand of trees near the school. The trees should be native to the area, not ornamental trees

planted by landscapers. On the walk, have the students collect leaves from trees and plants. Pick leaves off the trees, not from the ground. Pick a few from each area, do not strip a branch bare. Note areas that have sunshine and those that are shady. As leaves are collected, put them in bags labeled "sunny" and "shady" so that it will later be possible to determine what type of area the leaf came from. Collection of leaves may be done by the teacher before the lesson begins, thus eliminating activities 1 and 2.

B. *(Optional) If possible, take another walk through the same area at a different time of day. Note what areas are still mostly sunny and mostly shady. Collect leaves again as in Activity 2 A above from the mostly sunny and mostly shady areas. Students should begin to identify areas which are mostly sunny or mostly shady all day.*

C. In the classroom, put the leaves into piles labeled shady and sunny areas. Ask students to group the leaves in each pile in some way. This may be by size, color, leaf type, or some other characteristic. Then ask them to compare the kinds of leaves found in sunny areas to those of shady areas by comparing the number of leaves of each characteristic type in each pile.

or

3. In winter, students may note on which side of a road snow melts fastest on and if the same types of native trees and bushes seem to be found on each side of the road. Students can sketch the trees, take bark samples, or make rubbings by placing a sheet of paper over the bark and rubbing with a dark crayon. Bark, sketches, and rubbings can be sorted into bags labeled "shady area trees" and "sunny area trees". Back in the classroom the bags can be emptied and the samples classified as in activity 2C above.

MIDDLE CHILDHOOD ACTIVITIES

Materials: for the class
- Figures 1 - 4
- notebooks
- Student Handouts 2 and 3
- rulers for each group

Involve the students in the following activities:

Activity on land slope and growth differences:

1. This activity focuses on an investigation of physical environment factors which effect tree growth. Give students Student Handout 2 to study. Describe a hilly region in a forest with steep slopes, which contains a valley with a northerly slope and

southerly slope. You might draw a cross section of a valley showing these slopes on the blackboard. Ask students to observe differences and similarities between tree cross-sections on each slope. These are shown on Student Handout 2. Also ask them to try to identify characteristics of the environment which might be found on each slope. Students should be able to identify differences in tree ring size, more pronounced variations in ring growth, perhaps due to dryness, and larger diameter trees at the same age in Student Handout 2.

2. Ask students to make a list of all observations made for each tree cross-section.

3. Ask students to predict what tree growth to expect given the land feature shown on Student Handout 3. Have them make predictions for all sides of the hill. Students should give evidence to support their predictions. Ask students to draw maps and drawings to explain their predictions on Student Handout 2.

4. Instruct students to save notes, drawings, charts in a notebook for future reference.

INVENTING THE IDEA PHASE

TO THE TEACHER:

During this phase of the learning cycle the teacher will play a more directive role. At this time the teacher may wish to refer to notes, background information, etc. The teacher may use inquiry techniques to reinforce exploration activities or simply demonstrate and explain some of the ideas involved in concepts and relationships between the environment and tree growth. Students who were not able to answer problems or events given in the *Exploration Phase* should be led to an appropriate response at this time.

EARLY CHILDHOOD ACTIVITIES

Materials: for the class
- leaves and/or bark from the *Exploration* activities
- records or maps of plant species found in exploration activities

Involve the students in the following activities:

1. Following the activity which mapped an area around a tree, grove, or which blended from field or lawn to a tree covered area, students should examine their records of changes in plant type and/or plant numbers. They should discuss changes found in the areas explored. Ask, why do these changes occur?

or

2. Students can discuss and compare the types of leaves and/or bark found in shady

and sunny areas on their walk. Are differences found in type? In number? Can a hypothesis be developed which explains the differences found? (amount of light should be mentioned).

3. As a closure, students should be able to state that difference in surroundings influences plant growth in many ways. Plants under a tree experience less light, less rainfall, and live in a cooler environment than do plants not under a tree or in its shade.

MIDDLE CHILDHOOD ACTIVITIES

Materials: for the class
- Overhead transparency of Figure 5
- metric tape measure (if unavailable use meter or yard stick)
- meter or yard stick
- hammer
- cord or rope
- light meter (if available)
- white paper, notebooks, and pens
- pictures from magazines or books showing north and south facing slopes.
- *(Optional) Film: "Our Magic Land" - 16 minutes, or "Day in the Life of a Tree" - 28 minutes. Note: The above film titles, among others, may be obtained free of charge by contacting your local U.S. Department of Agriculture office.*

Involve the students in the following activities:

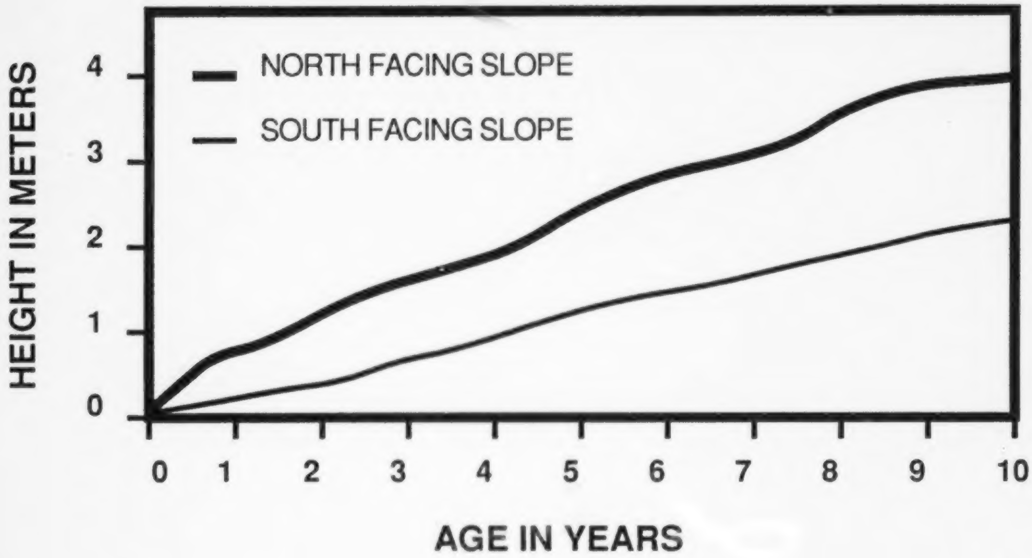
1. Begin with a short question and answer discussion summarizing results from the *Exploration Phase.* South facing slopes are warmer and dryer year round than north facing slopes due to greater amount of sunlight and evaporation. Amount of water and temperature are both factors which affect tree growth. Discuss conclusions reached by the various groups for each of the activities. They should conclude that slope direction environment affects tree growth.

2. *(Optional) Show a film relating to environmental effects on tree growth. Discuss concepts brought out in it relating to trees and what seems to effect their growth.*

3. Display an overhead transparency of a graph, Figure 1 and on Student Handout 4, showing the growth rate of trees on a northerly facing slope and a southerly facing slope. Ask students to discuss the meaning of the graph. Discuss observations the students made using questions involving Student Handout 3. The teacher may use other pictures or slides of north/south slopes as available to foster discussion. Bring students toward the key idea of how variation in temperature, light, and moisture helps determine the kinds of plants that can grow in an area.

Figure 1

TREE GROWTH ON TWO SLOPES



4. Field activities on school grounds.

   A. Mark off an area on a southerly slope 3 meters (9 feet) long by 3 meters (9 feet) wide. Mark off another area of the same size on a northerly slope. Use a cord to mark off areas. The sloping sides of a ditch or stream can be used as well as a hillside. If hill slopes are not available, use two differently lighted areas, one which is in sunlight, and one which is in shade for most of the day.

   B. Have students make two columns on a page in their notebooks. Each column will contain information for one of the marked off areas. Label one column northerly slope and the other southerly slope. In each column, ask students to list the types of plants found in that area, count the numbers of each type of plant found, make measurements of their overall height, and of the length of their stems. Use a light meter (if available) to measure the amount of light in each area. Record this information in each area's column. Ask students to write out a hypothesis regarding the differences they have found.

   C. Ask students to try to determine (by estimation) the population number of individual plants found in each area. Their method of determining this number should be recorded in their notebooks. The population could be estimated by sampling a few small sections in the area. The number for each area should be listed in its column in the notebook.

   D. Discuss similarities and differences found. Are the students able to make the inference that the amount of light is an important factor responsible for the differences they have found?

E. *(Optional) On another day, mark off two areas that include a field and an edge of a forest. Make two columns in notebooks and compare the areas as was done in B, C, and D above. Hypothesize about differences found.*

5. As a closure, review the roles that light intensity, moisture and temperature play in determining the types and numbers of trees that can grow in an area.

EXPANDING THE IDEA PHASE

In this final learning cycle phase the student must use and apply facts, concepts, and relationships concerning the tree growth environment. Students should refer to cumulative information notes and other sources of information. New contexts and different ways of looking at the ideas explained in the earlier part of the lesson should now be attempted. Following the *Expanding The Idea* phase, the teacher should check student outcomes with a quiz, performance test, and/or discussion.

EARLY CHILDHOOD ACTIVITIES

Materials: for the class
- writing materials
- construction paper
- paste or glue
- white unlined paper

Involve the students in one or more of the following activities:

1. Students may make a "sunny area leaf and/or bark" book and a "shady area leaf and/or bark" book by pasting examples of each on paper and then binding by stapling the pages together. A language experience story can also be written to accompany the books which explains the differences found between plants in each area.

or

2. Students can follow up and expand their walk from a grassy area to one under a tree by making a mural or bulletin board with a large tree in the center. Semicircles in a bright color can be used on either side of the tree to indicate the three regions in which plant growth was recorded. Students can fill these areas with green construction paper fringe and representations of weeds and other plants found in each region. Students could be divided into 3 teams, each responsible for filling in one of the areas. The bulletin board can carry a statement such as "The shady area under a tree has different plants because there is less light under the tree." Another statement may also be used, "The shady area under a tree has less plants because there is less light under a tree."

3. Students may write language experience stories describing their field activities and related in-class activities. They could also be divided into 3 teams, each of which makes a presentation to the class for one section of the mural made in the *Extending The Idea* activity.

MIDDLE CHILDHOOD ACTIVITIES

Materials: for the class
- 2 thermometers
- 2 cardboard tubes
- aluminum foil for covering cardboard tubes
- 2 rubber bands
- notebooks, pens

Involve the students in the following activities:

1. Ask the students to predict what might happen if the northern and southern slopes were at a higher elevation, with harsher wind and environmental factors? How would plant and tree growth be effected?

2. Ask the students to predict what might happen if the northern and southern slopes received more rain? If they received less rain?

3. Cover two cardboard tubes with aluminum foil. Locate a place on a north facing slope and on a south facing slope. If possible, these should be fairly close to each other. Better results will be achieved if the slopes are steep. Use ditches, ridges, or banks of a road cut. Choose places not shaded by trees.

    A. Place one thermometer inside a foil wrapped cardboard tube and deposit the tube on the north facing slope. Insert the thermometer into the other tube and deposit it on the south facing slope.

    B. Read and record temperature on each thermometer at regular intervals (eg. every 15 minutes for an hour, every 30 minutes for two hours, and every hour for half a day).

    C. Record findings and temperatures in notebooks. Graph and discuss the results.

or

4. Perform procedure as in number 3 above, comparing temperature in a grove of trees to temperature outside this grove; under a single tree at ground level; and at various heights above ground.

5. As a follow-up to numbers 3 and 4 above, discuss, "How are the types of plants different in variety and growth in the various temperature areas?" Students may wish to close this unit themselves with a panel discussion and report of findings during the field activities. Students may wish to display graphs, drawings, etc. concerning plant growth and environmental influences.

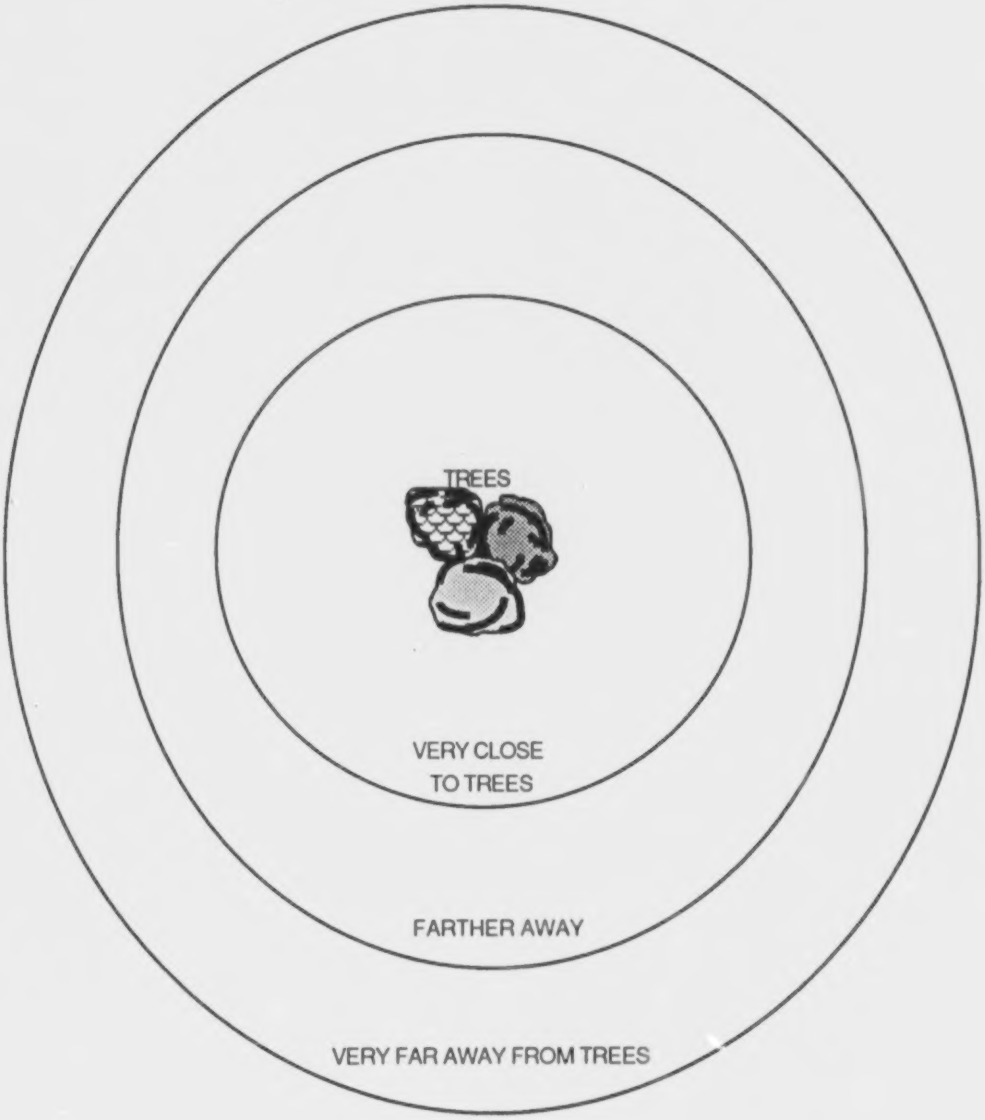
FINAL EVALUATION

The teacher may wish to make an ongoing evaluation of student products throughout the unit. The teacher may do this by:

1. making a report assignment;
2. evaluating a complete lab (field activity) report and interpretation analysis; and/or
3. noting each student's ability to construct leaf and bark books and/or contribute ideas to the construction of a mural.

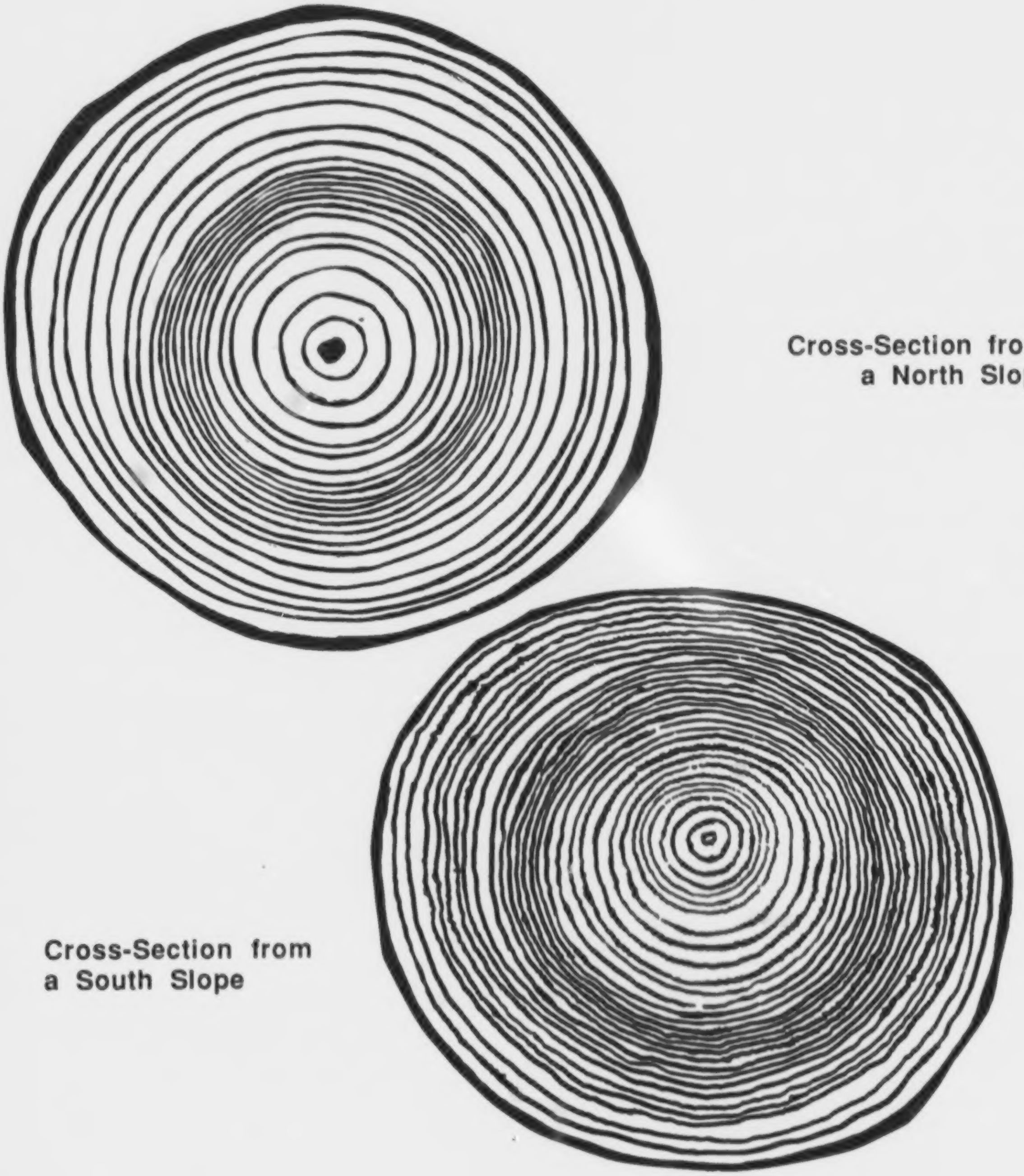
STUDENT HANDOUT 1

A Map of Plants Near A Tree


TREES
VERY CLOSE TO TREES
FARTHER AWAY
VERY FAR AWAY FROM TREES

STUDENT HANDOUT 2

Tree Cross-Sections Taken from a North and South Slope of a Steep Valley

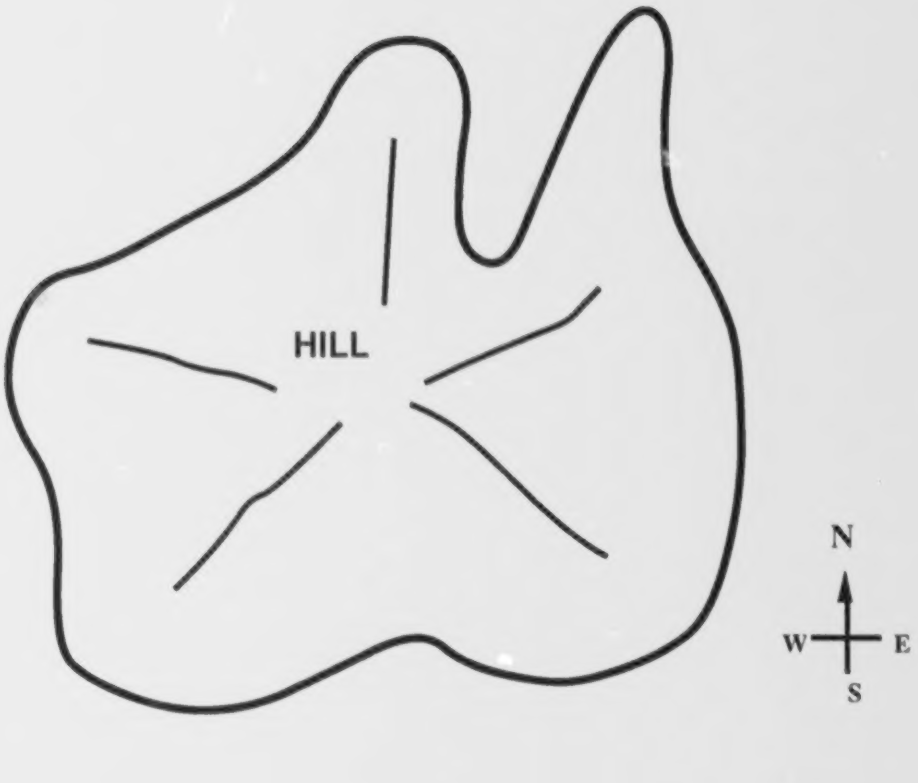


Cross-Section from a North Slope

Cross-Section from a South Slope

STUDENT HANDOUT 3

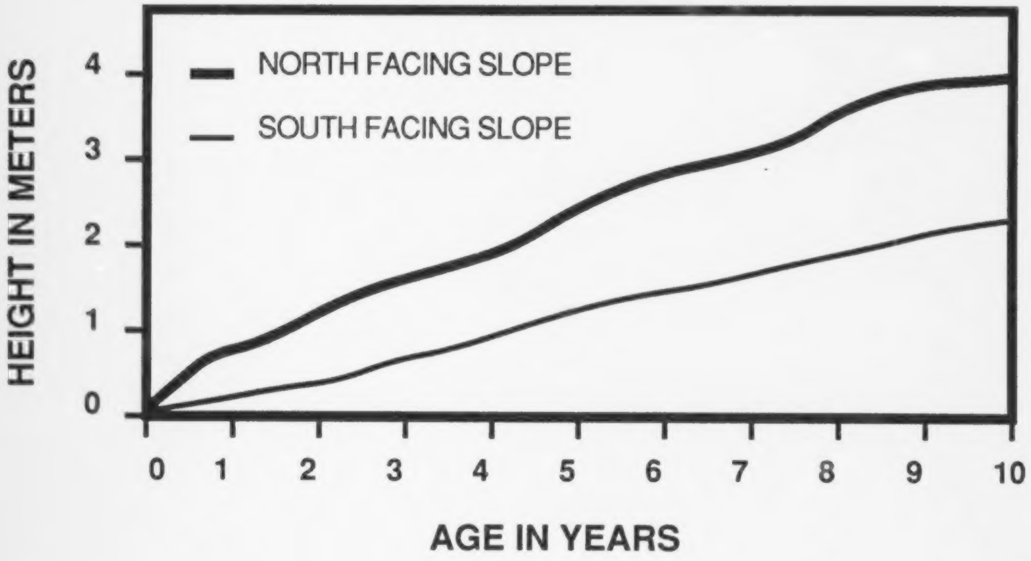
Prediction of Vegetation Growth on Different Sides of a Steep Hill

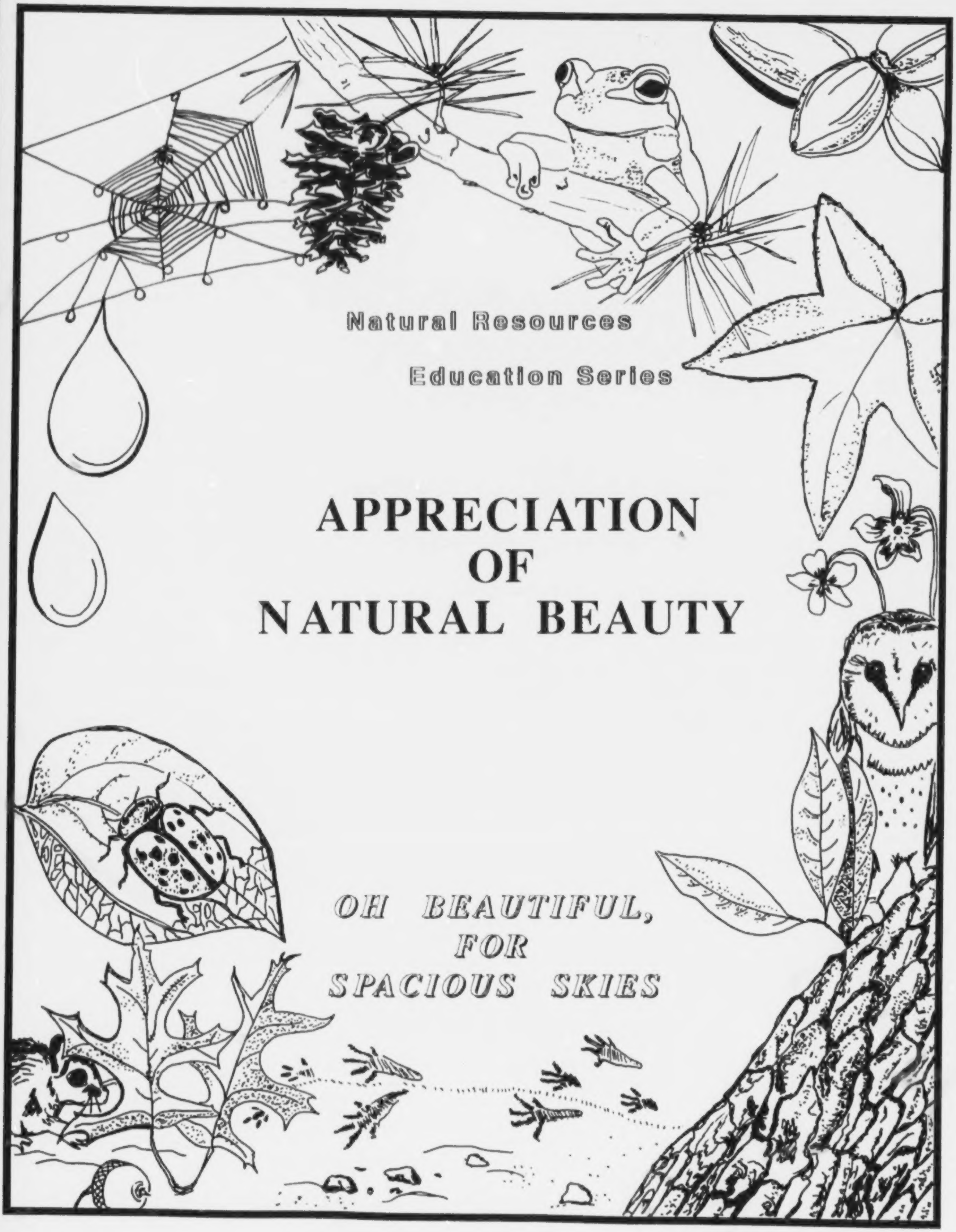


STUDENT HANDOUT 4

Tree Growth on Two Slopes

TREE GROWTH ON TWO SLOPES





Natural Resources

Education Series

APPRECIATION
OF
NATURAL BEAUTY

OH BEAUTIFUL,
FOR
SPACIOUS SKIES

The writing, development and, production of the ***NATURAL RESOURCES EDUCATION SERIES*** is a joint project with collaboration of project directors Dennis W. Sunal, The University of Alabama, and Mary E. Haas, West Virginia University, and the U.S. Forest Service. Partial funding was provided by the U.S.D.A. Forest Service. The initial author and series editor was Dennis W. Sunal. Revision of individual modules was carried out with the help of Mary E. Haas, and Cynthia S. Sunal. Assistance in creating appropriate activities, proof reading, and creating art work by computer for the many editions was provided by Jon Berninzoni, Elwin Dickerson, Tracy Johnson, Jane McGinnis, and Sukhwindar Singh. Final editing assistance on the text and artwork was performed by Audrey Rule. William Kline, Jr. assisted in training the original trial teachers. Content reviewers were specialists in the various module topics at the U.S. Forest Service including Monongahela National Forest staff members, Theresa Anne, Randolph Harrison, Linton Wright, and Harry Mohoney, and Northeastern Forest Experiment Station, Timber and Watershed Laboratory staff Pamela Edwards, David Helvey, James Kochendorfer, and Clay Smith. Teachers in the Randolph County, West Virginia Schools who first taught the modules and made recommendations for revisions were: Sandra Arbogast, Sara Basil, Ann Deloach, Karen Hall, Richard Leitner, Elizabeth McDonald, Linda Moore, Sharon Moss, Pam Mullennex, Jeff Ranhart, Theresa Skidmore, Rachel Snavely, Charles Swecker, Nancy Taylor, Angela Vance and Rebecca Wallace.

The ***NATURAL RESOURCES EDUCATION SERIES*** is designed to supplement textbooks with active learning lessons for students in the primary and middle childhood grades (K-8). The series consists of Understanding Our natural Resources Teacher's Guide and 12 Modules including Appreciation of Natural Beauty, Soils and Plant Growth, The Water Cycle, Natural History of a Tree, Recipe for Tree Growth, Tree Growth and Environment, Forest Processes, Managing Our Forest Resources, Growth of a Forest, Interactions of Forest Plants and Animals, Natural Watersheds, and Managing Our Natural Resources.

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APPRECIATION OF NATURAL BEAUTY

APPRECIATION OF NATURAL BEAUTY

OH BEAUTIFUL, FOR SPACIOUS SKIES

BACKGROUND INFORMATION FOR TEACHERS

This module would be appropriate with textbook and teacher prepared chapters and units relating to our earth (geology), ecology and environmental concerns, climate, and appreciation of nature through art, literature, and music. The activities within this module ideally require several days, but are flexible enough to be shortened and modified to fit the teacher's schedule. The teacher is advised to read over the unit carefully, and to plan accordingly. For module overview see Concept Map on page 14.

The purpose of this module is to enhance students' understanding of the beauty and design in nature. Aesthetics is the recognition of beauty and the assignment of value to it. People value that which they consider beautiful. Artists, through painting, sculpture, ceramics, and weaving, often try to express the beauty they see in nature. Musicians and writers, through their works, also try to express the beauty they find in nature. Aesthetics encompasses all forms of expression including music, literature, and art. Thus, the activities within this module allow students opportunities to search for beauty and to examine values that people over the ages have assigned to the many designs and relationships found within nature.

Nature's creations are eternal, yet vulnerable. Massive mountains disintegrate, eroded by the elements of wind, cold, rain, and heat. At the same time, other land masses are built up by other processes involving folding and faulting of earth materials. Vegetation and animal life persists, but is constantly modified by nature's various cycles of growth, life, decay, and death. Yet, when human technological advances are coupled with nature's own forces, the resulting changes in the design and balance in nature can be unpredictable and harmful to human well-being.

Technological development frequently leads to significant consequences for woodlands. Humankind's potential for destruction is well documented throughout history. Unfortunately, this potential for destruction is often realized. Consider the elimination of many animal species from our planet, the shrinking of productive natural land sites due to urban growth, and the increasing problem of contamination of the earth's natural resources such as water. Many of these events are consequences of people's endeavors to advance society through technology.

There is a need to educate each generation about recognizing and preserving the relationship between the natural environment and human development. There is a need to raise concern about, and awareness of the disappearing woodlands, natural plains, and wetlands. There is a need to examine and institute ways that allow nature and people to live together. Developing an appreciation for the beauty that is in nature is a beginning point for learning to live within and value the natural environment.

OBJECTIVES: Choose those appropriate for your students.

-Demonstrate increased knowledge of woodlands, forests, and other natural sites through drawing and writing.

-Observe and record interrelationships at natural sites, between people and nature.

-Develop one's own statement describing the beauty of a natural site.

-Analyze data/ideas to form personal interpretations about the importance of preserving natural resources and natural lands.

-Predict possible outcomes of any introduced change to a natural site or area.

-Discuss and analyze the positive and negative aspects of displacing a natural site through any change such as urban or industrial development.

-Develop a "natural beauty impact statement" for a specific site.

-Model in classroom activities the concept of aesthetics as related to nature.

EXPLORATION PHASE

TO THE TEACHER:

The initial phase of *exploration* involves interactive activities using many science process skills to help students, on their own, to discover basic concepts and relationships in aesthetics. The teacher should use this time to organize groups, observe interactions, and permit students to investigate possibilities themselves. Students should be asking questions, gathering first hand information and making connections to their previous experience in and out of school. Ideally the student should be confronted with a problem or event which cannot be explained by past knowledge.

EARLY CHILDHOOD ACTIVITIES

Note: Some advance preparation time may be needed for students build their "Before and After Cameras" and to collect their own set of "before" and "after" pictures from drawings of nature or magazines.

Materials: for the class
-Student Handout 1, "Before and After Camera"
-"Before and After Camera" materials, each student can construct their own. For deluxe group or teacher camera, provide;
    -a cardboard box from home or local merchant

-black tempra paint and brush to paint outside of box
-scissors to cut one cm (1/2 inch) round hole in bottom.
-tape, piece to hold lid on

For a standard model for each student, provide;

-Jello box or Cup of Soup box (brought from students home
-black tempra paint and brush to paint outside of box)
-scissors to cut one cm (1/2 inch) round hole in wide side
-cut along one side of the box so that it may be opened to look through hole in the side
-tape, put one piece on the cut side to close the box

- 3 (per group) blank drawing paper cut in half, "photographic paper"
- Student Handout 2 entitled "Nature Walk Record Sheet"
- one or more sets of "before" and "after" pictures, use Student Handout 3 or teacher collected pictures from magazines
- pencils and drawing materials, such as crayons and magic markers
- old newspapers and magazines for students to search out "before and after" pictures, ask the students to bring in from home.

Involve the students in the following activities:

Day 1

1. Help students construct their "Before and After Cameras", see Figure 1. Provide the students with Student Handout 1 and a completed model example. The cameras can be used in two ways. 1) Students can look through hole to see and remember the picture by removing lid. Just look through cut hole without a back cover on the box. 2) Students can pretend to take pictures by keeping the lid on and inserting "film", a piece of paper, in an open slot in the lid. The back cover of the camera should be taped on to hold the inserted blank paper (to draw on) or picture cutouts.

2. Inform the students that they will be taking a field trip and will record their observations of plant, animal, and insect life (on Student Handout 2, the "Nature Walk Record Sheet") in drawings and writing. The teacher may wish to group students in 3's to observe on all types of living organisms. As an option each group may then wish to study only plants, insects, or all other animals. See other modules in this Natural Resources Education Series for techniques of observing insects and other animals at natural sites.

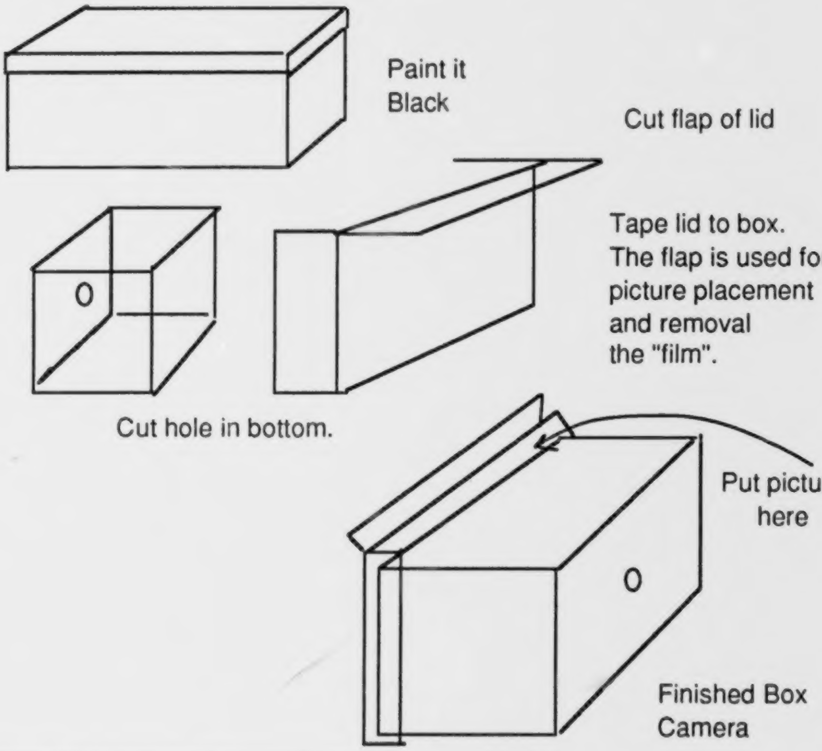
3. Take a walk through a nearby woods or field. Students will take along their homemade "Before and After Camera" to take pictures while you are walking. At a few, perhaps two, specific sites ask students to take "pretend photographs." Ask them to remember each photograph taken. The teacher should record a description of each "photo" and make a rough sketch on the blackboard later in the classroom.

4. While walking, ask if (or state that) this area would be a great place to put a gas station. The teacher can also substitute other words such as "school," "playground," "park," or "store." Note the students' responses to this (these) suggestion(s).

5. Back in the classroom, ask students to draw the observed scenes or items on each of their "blank photographs". Provide them with "blank photographic sheets" and other drawing supplies.

FIGURE 1
"Before and After Camera"

Box with removable lid at least 6" x 6"



Paint it Black

Cut flap of lid

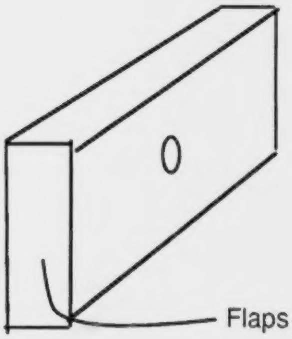
Tape lid to box. The flap is used for picture placement and removal the "film".

Cut hole in bottom.

Put pictures here

Finished Box Camera

Students -
Use a Large "Jello Box" or "Cup of Soup Box"



Children can paint and add details to Box Camera to reasemble real camera

Flaps for Pictures

Day 2

5. On the day following the hike (or on the same day if time is available), ask each group to show their "before" scenes or items they "photographed" with their "Before and After Cameras". What was the best place or thing to take a picture of? What made it good?

6. Ask student groups, now, to draw and/or describe an "after" scene for the same site where each of their "before" pictures were taken. What is different between the two scenes?

6. Show the class a set of "before" and "after" pictures. Other pictures which are "before and after" of a site should also be shown as available. For example, see Student Handout 3. Explain that some "before and after" pictures were taken by others and that you wanted to share them. The "before" pictures are of natural places before human development and use. The "after" pictures show the same places after cutting forests, removing topsoil, or the establishment of roads, homes, stores or industry. In cases where a hike to a developed site near the school is not possible, the students may participate in this activity alone. What is different between the two scenes?

7. Have students look through magazines and select before/after pictures. They do not have to be of the same piece of ground. They should be a picture of a natural scene and one with some human development in it. This can be done during this activity or several days before. "Before" pictures show an area or site in a natural state. "After" pictures show a developed area or site, e.g. forest to pasture, forest to farm, forest to a group of houses, field to gas station, farm to building, farm to parking lot, field to school. What is different between the two scenes?

MIDDLE CHILDHOOD ACTIVITIES

Note: This activity may take several days. The teacher may want to read ahead and adjust accordingly.

Materials: for the class and each group
- writing and drawing materials (including pencil and graph or plain paper)
- student journal notebooks
- yard or meter stick
- measuring tape

Involve the students in the following activities:

Day 1

1. Take the students on a 10-20 minute nature excursion of sites around the school. Such sites may include planted areas with bushes near the school building, nature trails, ditches, streams, areas where there are stands of trees, and/or areas not mowed or disturbed near the school land border. However, do not attempt to in-

clude every site on the school grounds within today's excursion. Also, the teacher has the option of allowing students to select sites for the excursion.

2. Encourage students to use all their senses except taste to observe their surroundings. They should write in their journal notebooks what they observe. As an option use Student Handout 2. Remind students to look for evidence of animal habitation. Periodically stop and ask students what they see, hear, and smell. What types of plants and animals are present at each site? Generally, this excursion should involve open exploration by the students with the teacher serves as a facilitator. See other modules in this **Natural Resources Education Series** for techniques of observing insects and other animals at natural sites.

3. At some sites, the teacher may ask the students if this area would be a great place to put a gas station. The teacher can also substitute other words for "gas station" such as "school," "playground," "house," "store," or "factory." Engage the students in discussion of the above question by having them assess some of the positive or negative aspects of the site, such as steep slopes, amount of trees, nearby streams, or extensive soil erosion.

4. Tell students to start thinking about what things need to be corrected or taken into consideration before they could develop or build on the site. Would they want to build on such a site?

5. Finally, hand out drawing and writing materials to each student and ask them to draw and describe in detail what they liked best and what they observed through their senses. Ideally, this should be done outside, but can also be done back in the classroom. Ask students if they noticed any areas that were neglected on today's excursion. If the students did notice any areas that were not explored today, ask them what they found potentially interesting about the site(s) and why they wanted to explore the site(s). What designs and patterns of nature did they see at any of these sites? The teacher may want to collect these drawings and notes about other sites around the school as a reference for the next day's activities.

Day 2

Divide students up into groups of 3-4 students each. Provide each group with a measuring tape or meter/yard stick, pencils and paper. The paper can be large graph paper or plain drawing paper.

A. As an in-class review, ask students to describe what they saw and did in the nature excursion walk. Include
   - a listing of the sites and
   - some specific details about the sites that were observed.

B. Explain to the students that they will be involved in a project that is designed to develop their environmental awareness, as well as their problem solving and decision-making abilities. Yesterday, they generally surveyed the school grounds and observed and noted what was included in them. Tell them that they will be going back outside first to map the general features of the school grounds as well as the respective dimensions of the land features.

1. To help younger students, the teacher may wish to draw a map on the board that shows the outline of the school building and school grounds including rough dimensions in metric or English units. The teacher should

   - explain what this map represents,
   - map out the sites that were used in the excursion, as well as their respective dimensions,
   - indicate the north, south, east, and west directions, and
   - have younger students copy this map down.

   Younger students should begin with this partial map already drawn. They should be asked to complete it by looking for sites that were not noted above.

2. For the older student, the teacher and the students, together, should come to some agreement about how the mapping will be done and about where boundaries will be set. In general, the teacher can explain to the students that it is most important that they all have a good map showing the overall plan of the school grounds.

   Older students can start their maps by first measuring the dimensions of the school and drawing the shape down on a map. The teacher can simply point the directions of north, south, east and west out to the students, or the students can use a compass themselves to figure out the directions. At the same time, the teacher can also ask students what they think would be the best way to accomplish the mapping of the school grounds. One student suggestion might include marking North, South, East, and West boundaries, and then sending groups into each of these areas to map the features.

C. When the drawings are complete ask the students to make generalizations about the area surrounding the school.

- Is there much open space such as a mowed field or vacant meadow, or a natural area where plants and trees have been allowed to develop with little interference by people?
- Is there a construction site near the school?
- Are the school grounds frequently soggy from flooding?

The next part of the activity in the *Inventing the Idea Phase* involves assignment of student groups to specific sites for observations over several days up. The student observations and recommendations for site development and planning will then be presented to the class in *Expanding the Idea Phase.*

INVENTING THE IDEA PHASE

TO THE TEACHER:

During this phase of the learning cycle the teacher will play a more directive role. At this time the teacher may wish to refer to notes, background information, etc. The teacher may use inquiry techniques to reinforce exploration activities or simply demonstrate and explain some of the ideas involved in this module. Students who were not able to answer the problems or events given in the exploration should be led to an appropriate response at this time.

EARLY CHILDHOOD ACTIVITIES

Materials: for the class
- "Before" and "After" pictures from the *Exploration Phase* activities

Involve the students in the following activities:

1. In small groups, encourage the students to examine the *Exploration Phase* pictures and discuss the differences between the "before" and "after" examples. The differences can be recorded on chart paper in two columns labeled "Before" and "After" or in the form of a "differences list."

2. Lead the whole class in a discussion of what has occurred as a result of development in natural areas, from the natural site undisturbed by people to the developed site. As the discussion is carried out, work in the following questions. Accept responses and comments from groups or individuals. Refer to the "Before" and "After" pictures as needed.

    A. What has happened to natural areas as a result of the cutting of trees or construction of houses, buildings or stores? (e.g. the trees, plants, and animals have changed and may have disappeared)

    B. What was the area important for before the building or factory was built? Why? (For example it may have been important for animal homes, places where trees and other plants could grow, hunting and fishing, camping and hiking, or other needs. Also, people need places to go to see what nature is like. Wildlife also need places to live where they are safe.)

    C. What is it most important for now? Why? (e.g. jobs -- so that people will have a place to work and make things other people use.)

    D. Which of the above is more important? Why? (answers should vary greatly)

    E. Can both be equally important? How? Why? (answers should vary greatly)

2. For closure, discuss with the students the definitions of the following concepts;

    - appreciation of beauty, or aesthetics in nature,
    - natural beauty,
    - human need for natural resources (eg. land, water, minerals), and
    - human development of natural areas.

MIDDLE CHILDHOOD ACTIVITIES

Materials: for the class
- writing and drawing materials
- student notebooks
- 1 poster board for each group

TO THE TEACHER:

In the *Exploration Phase*, all students performed the mapping activity and included the larger, more noticeable land features, such as the school, the playground, ponds, streams, the nature trails, drainage ditches, or historical remnants such as fences, in appropriate places on the maps. The teacher should begin the *Inventing the Idea Phase* by checking to see that each student performed the mapping activity correctly. This can be done by gathering the students back together in the classroom and by having them compare their maps and fill in missing features.

Day 1

1. After briefly reviewing *Exploration Phase* activities and finishing revision of their maps, divide the students up into new groups of 3 - 4 each. This time, assign each student group one or two sites on the school grounds. Include sites in which students themselves expressed interest. If possible, try to avoid using too many of the sites that students were shown in the *Exploration Phase*. Depending upon the amount of time available to the teacher for this activity, tell student groups that they will be making observations of the sites for one (or more) days. They may briefly observe the site before, during and after school and/or over several days at the same time. Student observations (descriptions, frequency, and drawings) should include among others;

    - animal (including birds and insects) habitats at the the site,
    - amount of visible erosion and possible causes,
    - types and numbers of plants and trees at site,

    - type of soil at site,
    - type or purity of water, if present, and
    - view of other areas from the site.

    It is important that all students in the group make the observations and do not constrain themselves to those things listed above. Students should be encouraged to examine as many features as possible at the site. Students can keep journal notebooks, which record;

- date and time of observation,
- drawings of the site,
- length of observation , and
- environmental conditions of the observation such as weather and temperature.

Pairs of students or individuals within each group can make observations at different times.

2. At the end of the observation period, allow students class time to get back into their groups to compile, organize, and summarize the data they have collected through observations. Students may find it easier to first organize observations according to the time of day. Tell students to look for general trends or patterns they observed in the way animals or insects or people use the site. Ask the students to summarize the observations into tables or in paragraphs of 1 - 2 pages. Some help from the teacher may be needed here.

3. In the student summaries, ask students to assess or describe some of the positive and negative features of the site. These features can include:

   - Does the site serve as a shelter area for ground-nesting birds and smaller mammals?

   - Is there severe erosion present at the site, or does the vegetation serve to anchor the soil?

   - Is there a steep slope or flat swampy area present that influences surface water runoff?

   At this stage, each student group has gathered information from their observations about the site. Further information can also be gathered from the students' own background, books, printed matter, and media.

4. Ask the students in each group to recognize a problem about the site. Recognizing and defining a problem is the first step in decision-making. The problem must be well-identified so that solutions which fit the problem can later be posed. Bring the students to the idea that environmental problems are often very complex, because "everything is connected to everything else." For instance ask the students:

   - Did you observe any interrelationships among people, animals, plants, or land features at your sites?
   - Do you predict a change in these interrelationships?
   - What things work together or affect each other?

Examples of statements which best describe a problem are the following:

- "To use the site so that natural resources are conserved and environmental problems are avoided."
- "To stop the nature trail (or other site) from eroding."

If students are unable to select a problem, the teacher can pose these questions:

- Should this site be developed into anything or left alone?
- Can this site be developed to improve its existing features such as plant or animal habitat?
- Can this site be made to have "more natural beauty"?

5. Have students summarize their work by organizing their drawings and written observations of the site on poster board. The poster should include;

   - a general description of the site,
   - student map where site is clearly marked,
   - summaries of student observations and data,
   - drawings, and
   - a clear statement of a problem regarding the site.

6. Ask students to consider the results of urbanization and the development on natural sites.
   - If a person rashly chose to build a factory at the existing site, what sort of changes will also be introduced at this site?
   - Will these changes be harmful or beneficial?
   - To whom or what?

   The teacher may conclude by summarizing and synthesizing the above activities. Most commonly, aesthetics is associated with art such as painting, sculpture, literature or music. However, the teacher can point out that there is aesthetic appeal in the designs found in nature such as hollow trees where birds or small mammals make their homes, or spider webs, or piles of brush or logs. When we experience a work of art we simultaneously appreciate both the satisfaction in the form and beauty of the art work and its value. Both characteristics join to create a special experience for us. This is called the aesthetic experience.

   Ask students to think about the many differences between what they consider to be beautiful and ugly in their "outdoor classroom," as well as what they value because of its beauty. Similarly, help students understand that there are many differences between what appeals to humans versus what appeals to insects, plants and animals. After considering these differences, ask them to try and define beauty and the aesthetic experience.

7. As closure, the teacher may remind the students that what they did was to look at the more general features of the land around the school, then zero in on a specific site and perform an "inventory" and develop an "environmental or natural beauty im-

pact statement." The inventory involved an identification and listing of the major types of plants, trees, animals, and other unique features such as water in the area.

The purpose was to get a clear understanding of the existing natural resources of the site as well as to appreciate the things that one must consider when introducing any change to a natural area. Similarly, the idea should be introduced that studying the many designs and interrelationships of nature requires time and careful, accurate observations. End with a definition of the terms aesthetics and natural beauty in nature.

EXPANDING THE IDEA PHASE

TO THE TEACHER:

In the final learning cycle phase the student must use and apply facts, concepts and relationships. Students should refer to cumulative information notes, fact sheets, etc. New contexts and different ways of looking at the ideas explained in the earlier part of the lesson should now be attempted. Following this phase, the teacher should check student outcomes with a quiz, performance test and/or discussion.

EARLY CHILDHOOD ACTIVITIES

Materials: for the class
- writing and art materials
- study prints and/or films and/or slides and/or resource persons related to lack of concerns for natural beauty in nature
- *Optional: student collection of forest seeds, bark, berries, stones, etc.*

Involve the students in the following activities:

1. Make a "Walk in the Woods" booklet. Draw pictures of "beautiful" woodland scenes with their occupants (plants, animals, people, etc.) and describe each with a phrase or sentence. Staple these together into a booklet with a "Walk in the Woods" cover page.

2. Ask students to write group or individual language experience stories about what they thought was happening in a set of "before" and "after" pictures. Ask them to include changes in the beauty of the site and the importance of the change.

3. *Optional: Illustrate for the students the consequences of people's lack of concern for the environment in general and forest lands in particular, using (as available) films, slides, study prints and resource persons/speakers.*

4. *Optional:*
   a) *Ask students to contribute items they think are typical of the forest, and they can find in and around their homes. These can be seeds, ants, bark, stones, etc. Add these to the items the teacher has already collected.*

b) Ask students to sort the items into collections.

c) Once collections are sorted out, ask students which of the items they can identify. The teacher may identify other items or may assign a group to each collection and ask them to use reference works to identify unknown items.

d) While originally classifying items into collections, or while identifying items, students should record characteristics of the collection they are working with, such as color, shape, symmetry, and texture. Is there a characteristic which seems to have more impact on them than the others? Do all the members of the student group note the same characteristic first? For example, is one person likely to first notice the color of a seed, while another notes its symmetry? Is there an item of the collection that they think is particularly nice, awesome, or beautiful and one that is particularly ugly?

MIDDLE CHILDHOOD ACTIVITIES

Materials**:** for the class
- Prepared bulletin board
- Student poster boards
- *Resource specialist (optional)*

Involve the students in the following activity:

1. Students in groups will present their site poster boards to the class they constructed during the *Inventing the Idea Phase* and discuss what they observed at the site, where it was located, and the problem they found with the site.

2. The teacher can ask individuals in the group:

   - What features were good/attractive and what features were bad/unattractive at the site? Why?
   - Which features were most important?
   - How did they select the problem?
   - Were there other problems with the site?
   - Is the problem a "problem" that humans or "nature" must deal with?

   Lead the students to the idea that humans often only assess situations from their viewpoint and rarely assess situations from the viewpoint of another species. What problems does this pose in "nature"?

3. Ask other students to contribute solutions or answers to each group's problems. Have students question the effects that these "solutions" would have on the natural site or on people, using some of the following:

   - What is a "good" solution versus what is a "bad" solution?
   - Are solutions that are good, only good for humans?
   - Does this site need to have any change introduced? If so, what change?

- What designs in nature were seen at the site? How could change affect these designs?

4. *Optional: As a summarization for this module, the teacher may invite a resource person from the United States Departments of Soil Conservation, Department of Agriculture, or Forest Service to speak to the students about their sites. The guest may appreciate seeing the student work, and then taking the students back out to the sites they observed and discuss the features they noted. The guest can also answer student questions at this time.*

   If a speaker is not available, the teacher has the option of doing this herself/himself or asking students within the groups what they liked or disliked about the site, its problems, and possible solutions. Do they have any new ideas or solutions? Did students consider the site beautiful or ugly? Why?

FINAL EVALUATION

Because of the nature of this module, engaging in the unit activities is a basic part of the aesthetic thought process. This experience should not be critically evaluated. The criterion for evaluation is the degree to which the student participated in the activities and synthesized together the concept of what is beautiful in nature with many other concepts concerning forest, land and water from previous modules.

The ultimate goal is to inculcate a spirit of appreciation for the beauty and design of the natural and a desire to preserve as much of it as possible for others (and other generations) to enjoy, while at the same time meeting the needs of humankind. This does not have to always be a dilemma solution where one side or the other is degraded. Young students may be asked to look at a "Before" picture and draw the "After" picture or vice versa. Use Student Handout 4 for this activity. Older students can be asked to experience works in literature, music, or art. The following questions may be used:

- What features of nature do you see in the works of literature, music, or art?
- What influences do these features of nature have?
- What is the main theme?

- What interrelationships do you see? (What things work together or affect each other?)
- What influence do you see as being the most emotionally powerful? (What makes you happy, sad, bored, etc. in this example)
- What might you change about this piece to create a different attitude?

- How powerful are forces of nature on people's lives?
- Are these forces positive or negative ones?
- Is this a beautiful piece of art/music/writing?

Possible selections of art works are:

"Landscape" by Alexander Cozens
"John Constable - Stoke" by Nayland
"Fur Traders on the Missouri" by George Caleb Bingham
"The River" by Claude Monet
"The Morning Bell" by Winslow Homer
"Wheat Field and Cypress Trees" by Vincent Van Gogh
"I am the Village" by Marc Chagall
"Song of the Lark" by Marc Chagall

Sources of art works include the following:

`Art Books
"Four Winds" Magazine, 703 W. Ninth, P.O. Box 156, Austin, Texas 78767
National Gallery of Art Reproductions and Publication, Publication Service, Washington, D.C. 20565

Recordings (possible selections are):

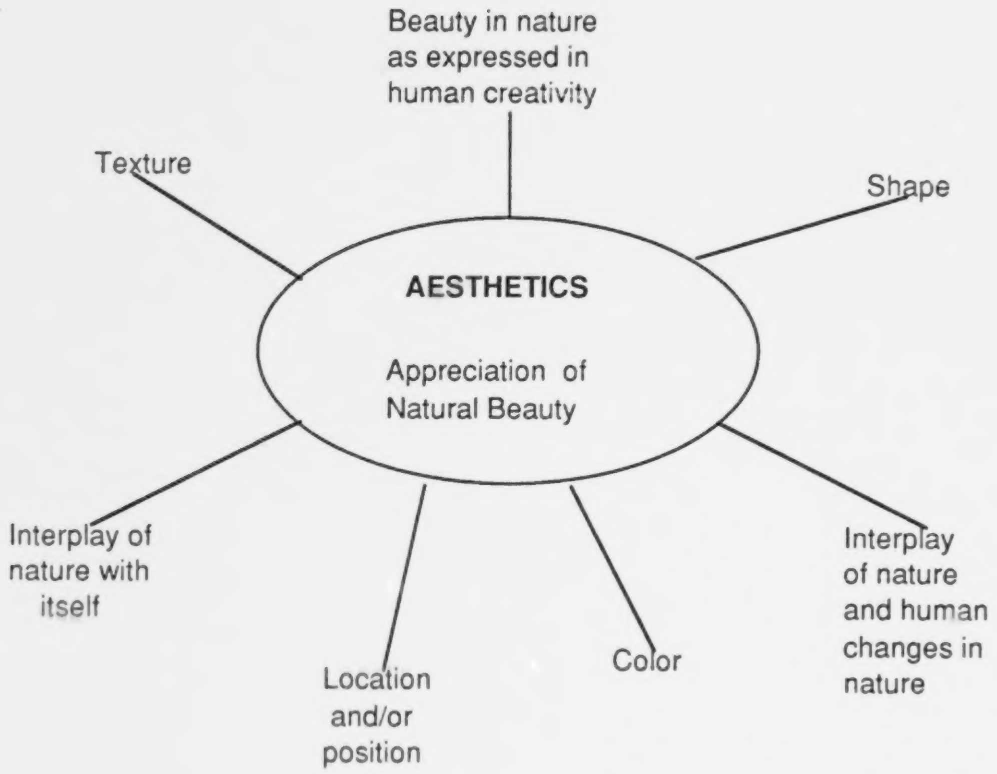
"E'tudes" by Chopin
"Wolf's Glen," "Der Freischutz" by Von Weber
"Parsifal," "Leitmotiv," "Ring of Nibelung" by Wagner
"Winterreise" by Schubert
"Rocky Mountain High," "Season Site" by John Denver
"Firebird Suite" (1919) by Stravinsky
"The Sea From Dawn Until Noon," "Dialogue of the Wind and the Sea," "Prelude to the Afternoon of a Fawn" by Debussy
"Ode to Joy" by Handel
"Oriental Fantasy" by Balakirev: Islamy
"Peaceful Evening" by David & Steve
"Midsummer Night's Dream" by Mendelssohn
"A Harvest of Dulcimers" by Dick and Ann Albar
"Grand Canyon Suite," "Sunrise or Sunset" by Grofe

Literature (possible selections are):

Easier Reading:
The Earth is Sore: Native Americans on Nature (long poem) by Aline Amon
Julie of the Wolves by Jean George
My Side of the Mountain by Jean George
Where the Red Fern Grows by Wilson Rawls

More Demanding Reading:
Call of the Wild by Jack London
The Light in the Forest by Conrad Richter
A Sand County Almanac by Aldo Leopold
The Trees by Conrad Richter
Mind of our Mother by Bob Samples
Wilderness and the American Mind by Thomas Nash
Plowshare in Heaven by Jesse Stuart

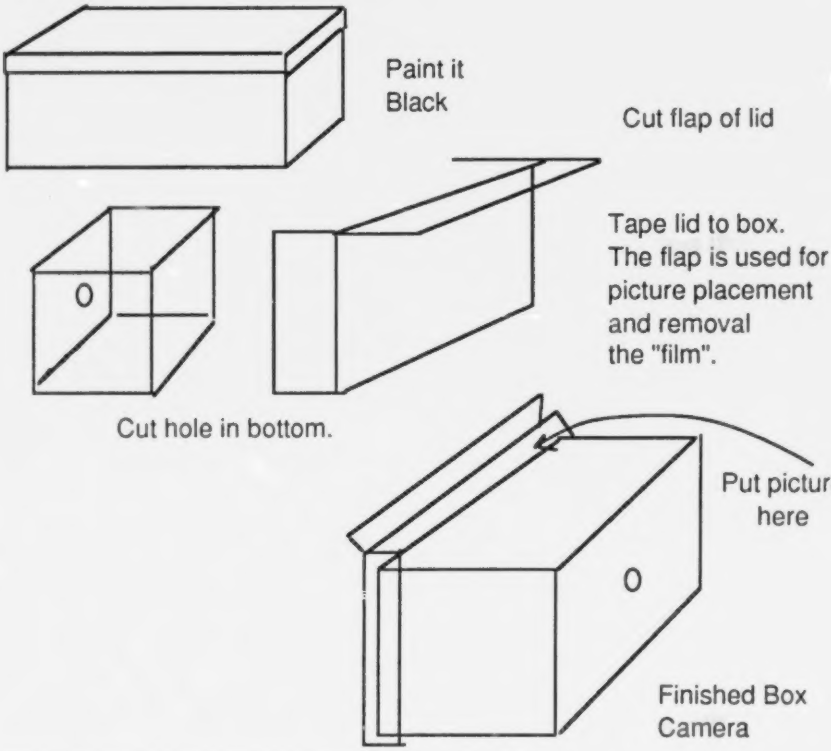
Appreciation of Natural Beauty
Module Concept Map


Beauty in nature as expressed in human creativity
Texture
Shape
AESTHETICS
Appreciation of Natural Beauty
Interplay of nature with itself
Location and/or position
Color
Interplay of nature and human changes in nature

STUDENT HANDOUT 1

FIGURE 1
"Before and After Camera"

Box with removable lid at least 6" x 6"



Paint it Black

Cut flap of lid

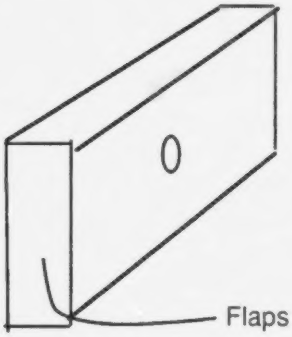
Tape lid to box. The flap is used for picture placement and removal the "film".

Cut hole in bottom.

Put pictures here

Finished Box Camera

Students -
Use a Large "Jello Box" or "Cup of Soup Box"



Children can paint and add details to Box Camera to reasemble real camera

Flaps for Pictures

STUDENT HANDOUT 2

(page 1)

Nature Walk Record Sheet

NAME(S) Date

On our nature walk I saw:

PLANTS

Drawing of the Plants

Draw on the back of this paper if you want to show more plants.

STUDENT HANDOUT 2

(page 2)

Nature Walk Record Sheet

NAME(S) Date

On our nature walk I saw:

ALL ANIMALS EXCEPT INSECTS

Drawing of the Animals

Draw on the back of this paper if you want to show more animals.

STUDENT HANDOUT 2

(page 3)

Nature Walk Record Sheet

NAME(S) Date

On our nature walk I saw:

INSECTS

Drawing of the Insects

Draw on the back of this paper if you want to show more insects.

STUDENT HANDOUT 3

"Before" and "After" Pictures

1. Which is the "Before" and which is the "After" picture?

2. What might have caused the picture on the right to look so different from the picture on the left?

STUDENT HANDOUT 3

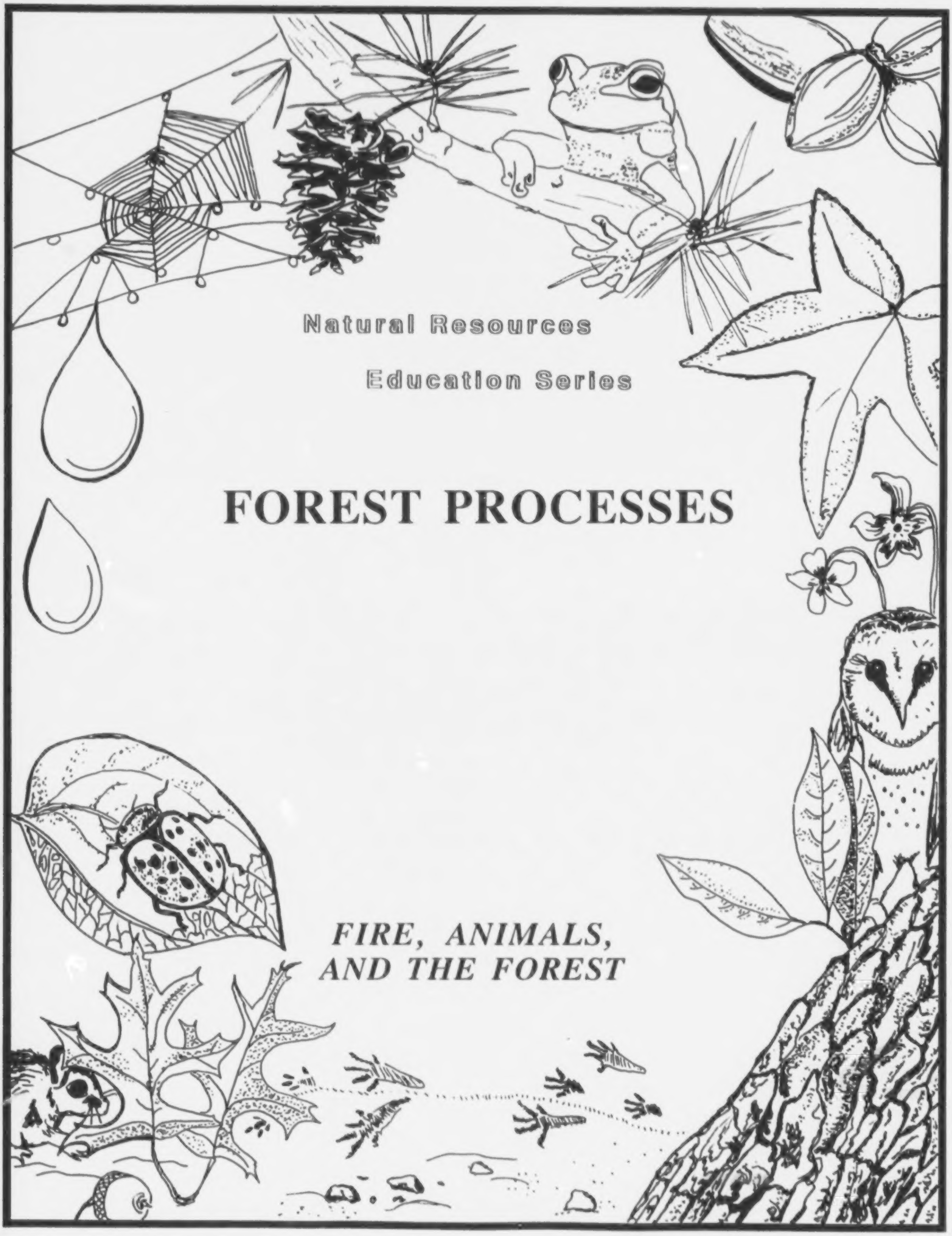
Teacher's Guide

Sandstone fixture over the portal of a castle in Westphalia, Germany, photographed in 1908 (left) and again 1969 (right). Acid rain produced by the air pollution generated in the heavily industrialized Ruhr region of Germany probably accounts for the severe damage. The castle was built in 1702. (Courtesy of Herr Schmidt-Thomsen.)

STUDENT HANDOUT 4

Student "Before" and "After" Pictures

Draw a picture of a natural scene as it would look now? As it would look 30 years from now?



Natural Resources

Education Series

FOREST PROCESSES

FIRE, ANIMALS, AND THE FOREST

BEST COPY AVAILABLE

The writing, development and, production of the ***NATURAL RESOURCES EDUCATION SERIES*** is a joint project with collaboration of project directors Dennis W. Sunal, The University of Alabama, and Mary E. Haas, West Virginia University, and the U.S. Forest Service. Partial funding was provided by the U.S.D.A. Forest Service. The initial author and series editor was Dennis W. Sunal. Revision of individual modules was carried out with the help of Mary E. Haas, and Cynthia S. Sunal. Assistance in creating appropriate activities, proof reading, and creating art work by computer for the many editions was provided by Jon Berninzoni, Elwin Dickerson, Tracy Johnson, Jane McGinnis, and Sukhwindar Singh. Final editing assistance on the text and artwork was performed by Audrey Rule. William Kline, Jr. assisted in training the original trial teachers. Content reviewers were specialists in the various module topics at the U.S. Forest Service including Monongahela National Forest staff members, Theresa Anne, Randolph Harrison, Linton Wright, and Harry Mohoney, and Northeastern Forest Experiment Station, Timber and Watershed Laboratory staff Pamela Edwards, David Helvey, James Kochendorfer, and Clay Smith. Teachers in the Randolph County, West Virginia Schools who first taught the modules and made recommendations for revisions were: Sandra Arbogast, Sara Basil, Ann Deloach, Karen Hall, Richard Leitner, Elizabeth McDonald, Linda Moore, Sharon Moss, Pam Mullennex, Jeff Ranhart, Theresa Skidmore, Rachel Snavely, Charles Swecker, Nancy Taylor, Angela Vance and Rebecca Wallace.

The ***NATURAL RESOURCES EDUCATION SERIES*** is designed to supplement textbooks with active learning lessons for students in the primary and middle childhood grades (K-8). The series consists of Understanding Our natural Resources Teacher's Guide and 12 Modules including Appreciation of Natural Beauty, Soils and Plant Growth, The Water Cycle, Natural History of a Tree, Recipe for Tree Growth, Tree Growth and Environment, Forest Processes, Managing Our Forest Resources, Growth of a Forest, Interactions of Forest Plants and Animals, Natural Watersheds, and Managing Our Natural Resources.

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FOREST PROCESSES

THE ROLE OF FIRE AND ANIMALS IN THE FOREST

BACKGROUND INFORMATION FOR TEACHERS

The interactions between agents of change are essential in understanding forest processes. These three agents are fire, interactions of insects and mammals, and the forest. This module would fit with science textbook and teacher prepared chapters and units involving topics such as where plants and animals live, animals and plants are important, food chains and food webs, predator/prey, relations, succession and ecosystems. Advanced preparation is needed for this module. The teacher should read ahead and plan accordingly.

An organism's environment incorporates its physical surroundings, other organisms of its own kind, and organisms of other kinds. Ecology deals with the ways the organism relates to all these factors. Thus, forest ecology focuses on interactions and relationships with the environment and among trees (and all forest plants) and with different animal groups. Ecology of a forest involves relationships within and between its parts. This module will help students understand a forest ecosystem.

Forests respond to changes through the responses of the parts making up the system. To maintain equilibrium, homeostasis, an ecosystem starts with the individual organism's ability to respond and adjust physiologically or behaviorally. The success of the organism in maintaining homeostasis is reflected in its ability to generate offspring that can reproduce. Populations of some organisms such as trees do not respond as well to environmental changes as do annual plants, insects, and mice. The stability of a system results from the ability of the population to react to changes and disturbances in the ecosystem. Stability involves persistence. Persistence is viewed as the resilience of a system - its ability to absorb changes and still persist and the speed with which it returns to its original condition.

If a system is so greatly disturbed that it is unable to return to its original state, a different ecosystem may replace it. For example, in northern Britain, moorlands replaced felled forests of Scotch pine. In Appalachia, spruce forests were replaced with blueberry and stunted birch. Changes in physiology, behavior, or morphology of a species occur due to the thriving of some individuals who are better able to cope with environmental conditions. The individuals best adjusted to environmental conditions make the greatest contribution to future generations by leaving the greatest number of progeny in the population. Selective pressures on individual organisms in an environment may reduce the fitness of some and increase the fitness of others.

Three important events influencing the equilibrium of the forest are fire, and the interactions of insects and mammals. Fires can be both a friend and an enemy to a forest. Fire can influence patterns of vegetation and species composition However, fire is potentially the forest's greatest enemy because of its power to destroy so much timber and to decrease other forest values in such a short time. Fire loss, though, is lower than the loss from insects or disease. The nine standard causes of wildfire in the United States are shown in Table 1.

Table 1

Causes of Wildfire

Incendiary (Willful destruction)	24-26%
Burning of Debris	19 - 24%
Smokers	10 - 12%
Lightning	11%
Miscellaneous	7 - 9%
students	6 - 9%
Railroad	6 - 7%
Campers	4 - 5%
Equipment	2 - 5%

Two important terms which relate to fire and forest processes are "fire risk" and "fire hazard". Fire risk refers to the chance of a fire starting from some causative agent. A lightning storm poses a large fire risk. Fire hazard refers to fuel that by its composition and volume, condition and location forms a special threat because of easy ignition and difficulty of suppression. A lot of dry leaves and brush on the ground constitutes a fire hazard.

While fire is potentially the greatest enemy of our forests, insects destroy more timber each year in the U.S. than any other single factor. Actual losses of timber from insect depredations run into billions of board feet each year. The forest is the natural home of thousands of species of insects. Examples of important forest insects are listed in Table 2. Fortunately, not all of them are destructive insects.

Table 2

Insects Most Important to Forestry

Name	Order	Wing Characteristics
Beetles	Coleoptera	Hard first pair of wings
Butterflies/Moths	Lepidoptera	Scales on wings
Wasps	Hymenoptera	Four membranous wings
Flies	Diptera	Only one pair of wings
Aphids/Scale	Homoptera	Wings held featherlike over their backs
Bugs	Hemiptera	Half of front wings hard
Termites	Isoptera	All wings same length

These insects differ widely in the kind and amount of damage they inflict and in the period of their life cycle in which they do damage. Some insects attack trees only when in their larval stage. Others carry out their destructive work as adults. Some insects prey on flowers, cones, buds, or leaves, while others damage only the trunk of the tree. Table 3 lists types of destructive insects. All insects, including those that are tree damagers or destroyers, are usually held in check by their natural enemies or an unfavorable environment. The population of a destructive insect is said to be in an endemic stage if it is present in normal numbers and is doing little or no damage to trees.

Table 3

Destructive Types of Insects

Sucking insects
Defoliators
Bark Beetles
Wood Borers
Terminal Feeders
Root Feeders
Gall Makers
Seed Insects

With the use of long-range forest management practices such as the selective cutting of susceptible trees, almost "bug-proof" forests can be obtained. These methods are called indirect control.

Direct control, on the other hand, involves methods to alleviate aspects of the problem. Direct control methods include the following:

1) trapping the insects by various methods,
2) piling and burning slash after logging,
3) felling and removing infected trees,
4) dunking felled trees in a millpond,
5) debarking logs and exposing the larvae to the sun,
6) burning the peeled bark,
7) piling the logs and burning or spraying them with insecticides, and
8) spraying from above with low flying aircraft.

The forest is also the natural home of many game and fur-bearing animals as well as insects and has served for centuries as a pasture for domestic stock. Forests harbor numerous rodents that are interesting but likely to be considered useless, if not harmful. Various effects of civilization, which diminish the natural feeding and breeding grounds of certain mammals, may also drive the mammals to feed upon bark or twigs during the winter to an injurious extent.

Because many of the mammals themselves are important natural resources, there is increasing emphasis on integrated management approaches that deter wildlife without harming it. Some deterrents involve noxious repellents, compounds that produce an undesirable taste, odor, feel or that otherwise modify behavior patterns.

Another important alternative in deterrence is habitat management. This strategy involves removing materials or not leaving attractive food or habitat near reforested areas. Accumulations of brush, for instance, are agreeable homes for pocket gophers. Deer find apples appetizing, so planting apple trees near newly planted stands or nurseries should be avoided.

Forest life abounds with benefactors. If not for millions of birds, insects would have explosive growth. Woodpeckers especially are significant and have been known to kill practically the entire brood of Engelmann spruce beetles in specific areas. Skunks have been known to consume 14,520 white grubs to the acre. Overpopulation of insects causes much damage to the forest.

OBJECTIVES: Choose those appropriate for your students

- identify types of forest damage -- fire, insect and mammals, and disease.

- identify insects and mammals that damage trees.

- compare damaged forest areas with healthy areas.

- predict possible forest areas susceptible to damage.

- explore relationships between animals and some environmental factors relating to maintaining equilibrium in forest processes.

EXPLORATION PHASE

TO THE TEACHER

The initial phase of exploration involves interactive activities using observation and other science process skills to help students, on their own, to discover basic concepts and relationships in forest processes. The teacher should use this time to organize groups, observe interactions and permit students to investigate possibilities themselves. Students should be asking questions, gathering first hand information and making connections to their previous experience in and out of school. Ideally the student should be confronted with a problem or event which cannot be explained by past knowledge.

EARLY CHILDHOOD ACTIVITIES

Materials: for each group
- 1 shovelful of soil with leaf litter from a woods or older stand of trees put in zip-lock bags
- 2 small pieces of rotting wood from a forest in zip-loc bags

- 1 plastic garbage bag
- 1 glass jar with lid
- magnifying glass for each student
- chart paper (large drawing paper or long section of computer print out paper)
- 2 pieces of burned wood (from a campfire or fireplace)
- 1 roll of tape

Involve the students in the following activities:

TO THE TEACHER:

Before class day, dig up 3-4 shovelfuls of soil with leaf litter in a moist woods setting. Put the dirt in plastic zip-loc bags. Collect a variety of rotting pieces of wood and put in plastic garbage bags also. In class, lay out garbage bags to serve as work placemat areas for students. Organize groups of 3 to a work area.

1. Ask each student to pick up a zip-loc bag with the dirt collected earlier in the forest and to carry it over to their work area and dump it on to the plastic garbage bag. Distribute a magnifying glass to each student. Ask students to spread out the dirt and see what they can find in it. Ask them to especially look for insects in it. Any insects found can be put in a jar with a lid. Have each group share what they found with the class. Record findings on chart paper by taping and labeling the variety of materials found.

2. Repeat number 1 using the wood collected in the forest. This could occur on the next day. Have each group share what they found with the class and record findings/drawings on chart paper.

3. Examine pieces of burned wood obtained from home or a picnic site. What does the wood look like? How does it differ from wood that is not burned? What does the burned wood feel like? Record findings/drawings on chart paper.

4. Ask students' groups to share their findings by discussing and displaying their chart paper.

MIDDLE CHILDHOOD ACTIVITIES

Materials: for the class
- Golden Guide to Insects, Golden Guide to Insect Pests, or other reference book on insects
- hand lens for each student
- field notebook or drawing paper for each group
- rotted log and surrounding soil from moist forest floor (collected and plastic bagged until activity) for each group
- log freshly cut (not decayed, could be pieces of limb) for each group
- burned wood (from a campfire or fireplace) for each group
- 1 roll of tape for each group

Involve the students in the following activities:

1. Before class day, bring in a rotted log and soil, freshly cut wood, and a burned log from the forest. Organize the students into groups of three and distribute samples to each group. Have the students record and draw their observations about it. Ask the students to devise a chart to organize their observations. Suggest that the students label type examples of the items reported.

2. *Optional: Have students go outside and record observations of living wood for a short time period, 5 - 10 minutes.*

3. Ask students to brainstorm and list how fire and animals change forests. Ask the groups to share their findings by displaying and discussing their charts.

INVENTING THE IDEA PHASE

TO THE TEACHER:

During this phase of the learning cycle the teacher will play a more directive role. At this time the teacher may wish to refer to notes, background information, etc. The teacher may use inquiry techniques to reinforce exploration activities or simply demonstrate and explain some of the ideas involved in concepts and relationships of forest processes.

EARLY CHILDHOOD ACTIVITIES

Materials: for the class
- rotted wood samples and burned wood samples from *Exploration* activity
- insects collected from dirt and wood samples in *Exploration* activity
- Golden Guide to Insects or other reference book on insects
- magnifying glasses
- picture of a deer, see figure 1 or use library book
- drawing materials for each student

Involve the students in the following activities:

1. Ask the students to compare the rotted wood with the burned wood used in the *Exploration* activity. What do they observe about each? On the blackboard, chart their observations under two columns: Rotted Wood and Burned Wood. If similar characteristics are noted draw a line linking the characteristic noted in one column with that noted in the other column.

2. The students should try to identify insects found during the *Exploration* activity using the Golden Guide to Insects or a similar source. Use magnifying glasses for identification if needed.

3. Ask the students whether they think insects and fire can be harmful to trees in the forest. Have them describe any experiences they have had with observing the effects of insects or fire on forests. Have them draw a picture of a tree that has been attacked by insects or fire.

4. Ask some of the following questions:

   a. Insects and fire can hurt trees, could mammals also hurt them?
   b. Do you know of any animal that might eat part of a tree?

   c. Are there be some trees an animal might like to eat while there are others the same animal might not like to eat?
   d. Why would this be so?

   e. How does this change a tree over time?
   f. What happens when many animals are eating off trees? (This results in overgrazing which kills small trees.)

If students cannot think of animals which might eat trees, the teacher can tell them deer sometimes eat tender branches of young trees when they are very hungry -- especially in winter when a lot of snow may make it hard for the deer to get at grass and other ground plants. Also, squirrels eat and hide nuts from trees. Is this helpful to the forest?

5. Provide a closure with examples demonstrating how fire and animals are part of forest processes and can affect the health of a forest.

MIDDLE CHILDHOOD ACTIVITIES

Materials: for the class
- student observations in the form of drawings and recordings from the previous *Exploration* phase.
- blackboard
- Student Handout #1

Involve the students in some of the following activities:

1. Ask the students to contribute the data they have gathered during the *Exploration* to a class discussion.

2. With the help of the students, put the data together on the blackboard. The teacher may wish to organize the data in a form similar to that which is illustrated in Table 1.

3. Students may wish to copy chart on to Student Handout #1.

Table 1

What is in This Piece of Wood?

(Draw or name organisms observed)

	Rotted Wood	Living Wood	Newly Cut Wood
Animals			
Plants			
Insects			
Microorganisms			

4. Encourage students to discuss the health of a forest and draw analogies to the requirements of a healthy body (if necessary). Questions to pose to students are:

How can we tell if a forest is healthy?

Why is it important to have healthy forests?

How can we keep forests healthy?

Have students reflect on these questions. Record possible answers in notebooks. Students may work in groups. Expand answers using information provided in the Background section given at the beginning of this module.

5. For closure of the activity for the *Inventing the Idea* phase, discuss with the students the definitions of the following concepts (not necessarily in the order listed below):
    a) equilibrium
    b) persistence of tree species within forests
    c) destroyers and benefactors
    d) evidence of animal interactions such as leaf defoliation, damage etc.
    e) fire and change in forests.

EXPANDING THE IDEA PHASE

TO THE TEACHER:

In the final learning cycle phase the student must use and apply concepts and relationships concerning forest processes. Students should refer to cumulative information notes, fact sheets, etc. New contexts and different ways of looking at the ideas explained in the earlier part of the lesson should now be attempted. Following *Expanding The Idea,* the teacher should check student outcomes with a quiz, performance test and/or discussion.

EARLY CHILDHOOD ACTIVITIES

Materials: for the class
- Student Handout 3

Involve the students in the following activities:

1. Discuss fire safety in the forest. This is the time to use "Smokey the Bear" or the United States Forest Service materials. The county extension agent or local U. S. Forest Service office can be helpful in locating materials and perhaps in locating a guest to come into the classroom to talk about fire safety in the forest. After working with the fire safety materials and perhaps having a visit from a guest speaker, the students can demonstrate or describe how to build a safe fire, set up rocks to contain a cooking fire, put out a simulated fire, and other activities which indicate safe practices.

2. Ask students to describe and summarize the forest processes they observe in Student Handout 3, and relate students' descriptions to fire, insects, and mammals.

MIDDLE CHILDHOOD ACTIVITIES

Materials: for the class
- life history notes found in Student Handout 2

Optional:
- Student Handout 4
- cologne
- filter paper
- toothpicks
From a nursery obtain:
- Japanese beetle pheromones
- marigold plants or seeds to grow

Involve the students in the following activities:

1. In this *expansion* phase, the class considers natural processes in forests, woods, or even tree stands in the local neighborhood. Ask the students to think about the three factors which have been discussed in relation to their impact on forests discussed -- fire, insects, and mammals. Issues to be considered can include the following:

    a. If one factor becomes dominant how will we compensate?
    b. How can we best manage our forests?
    c. What are the best species of insects and mammals to use in managing our forests?
    d. What species of insects and mammals best survive? Under which conditions?

    e. What species benefit each other?
    f. When can fire help productivity in a forest? How?
    g. What benefits does fire have for wildlife?
    h. What detriments does fire have for wildlife?
    i. If food supplies diminish, what will occur?

    As students reflect on these questions, record possible answers on the blackboard. Expand answers using information provided in the Background section given at the beginning of this module.

2. *Optional: Use Student Handout #2, Life History Notes, and a discussion of food chains and or predator - prey relationships to help students consider the same questions above.*

3. *Optional: Make a list of insects found in the piece of wood using the Golden Guide to Insects or another source book. Then have students try to break the list down and put the identified insects in two columns with the headings,"Beneficial to Forest Health" and "Detrimental to Forest Health."*

4. *Optional: Ask students to construct pooters (see Student Handout 4) and take them home. The pooters should be placed outside overnight. If students live near forested areas, pooters can be placed in the forest. Students can bring the pooters back to class 1 to 2 days later. Insects collected in the pooters can be observed and identified by students. Which of these insects are beneficial to forests? Which are detrimental to forests? The students should release the insects after they have cataloged, drawn, and attempted identification. Insects should be released within 12 hours of collection in an overgrown area so they can find cover.*

5. *Optional: Direct students to devise their own experiments for attracting insects at home or on school grounds. One example of such an experiment involves the following procedure. Place insect pheromone on a filter paper. Place cologne on*

another filter paper. Have one extra clean filter paper handy. Secure each of the three filter papers to the ground with toothpicks in an open area in late spring, early fall. Monitor for parts of a day(especially early morning and late afternoon). Students can also monitor the filter paper in shifts. These questions are to be answered. To what paper are the insects attracted? How frequently? Would trees have some substances related to them which might attract insects? What are some instances where trees or other vegetation releases a scent that attracts insects? The teacher may direct students to identify the materials, questions to be answered, methods to do it, and results.

6. Ask students to describe and summarize the forest processes they observe and discussed above. Student Handout 3 may be used to relate students' descriptions to fire, insects, and mammals.

EVALUATION

Evaluation of early childhood students can occur in an activity similar to those in *Expanding The Idea.* Students should be able to demonstrate or describe appropriate fire safety practices and effects of animals on forests.

After discussion, older students can be asked to write responses to the questions similar to those in the middle childhood *Expanding The Idea* activity. One of the optional activities not used in the lesson may be used here as an evaluation. These responses can serve as an evaluation of students' understanding of the forest processes presented in this module. Students can also be asked to identify those processes observed in pictures similar to Student Handout 3.

STUDENT HANDOUT 1

What is in This Piece of Wood ?

	Rotted Wood	Living Wood	Newly Cut Wood
Animals			
Plants			
Insects			
Microorganisms			

STUDENT HANDOUT 1

Life History Notes

Life History Notes -- Raccoon

Scientific Name: *Procyon lotor*
Other Common Names: Coon, Ringtail
Mating: Monogamous. After mating the male isn't interested in family life and leaves all responsibility for raising the young to the female.
Breeding Period: March-June, peak in April-May
Litters Per Year: 1
Litter Size: 2-7; average 4
Birth Weight: 2 1/2 oz. (71 grams)
Eyes of Young Open: at 3 weeks
Young Leave Nest: at 2 mo.
Breeding Age: 1 year
Adult Weight: 5-35 lb (2.3-15.9 kg)
Adult Body Length: 18-18 in. (46-71 cm)
Adult Tail Length: 8-12 in. (20-30 cm)
Life Expectancy: 3-4 yrs.; maximum 13 yrs.
Movement: home range 1/2-1 mile (0.8-1.6 km.)
Feeding Period: Mostly at night
Foods: Omnivorous--fruits, nuts, grains, eggs, insects, crayfish, frogs, and mice. It eats many things partly because it can crush hard foods like acorns and shellfish with its large molars. It often forages for food in water and sometimes dunks its food before eating. Often it eats its food without washing it. **Description**: Medium-sized mammal with grizzled gray-black fur, black face mask, and alternating rings of black and yellowish-white on its bushy tail.
Living Areas: Pioneers found many raccoons in the forests. It likes large, hollow trees in woods for dens but will also use ground burrows, rock crevices, drain tiles, and old buildings. Raccoon are sociable and often den with others. They don't hibernate but will nap for long periods of time in a secure shelter if it is very cold. Sounds: Raccoons make many sounds. Females will twitter to reassure their young. Males will growl and snarl is they are angry. Raccoons also howl. Note: Information for the Life History Notes above has been obtained from the Ohio Department of Natural Resources, Division of Wildlife's Publication, Life History Notes.

Life History Notes -- Eastern Gray Squirrel

Scientific Name: *Sciurus carolinensis*
Mating Behavior: Polygamous
Breeding Period: December-January and May-June
Gestation: 44 days
Litters per year: 1 or 2
Litter Size: 3-5
Birth Weight: 0.42 oz. (12 grams)
Eyes of Young Open: at about 36 days
Young Leave Nest: at 7-8 weeks
Young Weaned: at 10-12 weeks
Breeding Age: Females -- 6-8 mo. Males -- 9-11 mo.
Adult Weight: 12-24 oz. (340-680 grams)
Adult Body Length: 8-10 in. (203-254 mm).
Adult Tail Length: 7.8-10 in. (198-254 mm.)
Life Expectancy: 1 year average, maximum of 10 years
Movement: Female--average home range of 8 acres (3 hectares) Male-- 17 acres (7 hectares) Feeding Period: mostly 8-10:00 a.m. and 2-4:00 p.m.
Foods: nuts, seeds, and fruits of hickory, beech, oak, black walnut, tulip tree, sugar maple, flowering dogwood, buckeye, wild grape, pawpaw, persimmon, butternut, and black cherry; also insects.
Description: overall grayish color, bushy tail, whitish belly, white-tipped tail hairs, in summer it is yellowish-brown along sides and on feet.
Before Settlement: There were many Eastern Gray Squirrels in eastern forests before settlement by the pioneers. They often ruined the crops planted by pioneers so sometimes a bounty was paid for squirrel skins. As hardwood forests were cut down, squirrel populations declined and restrictions on hunting them began.
Today's Living Areas: Eastern Gray Squirrels live in forestlands with a fall population density of about 1 squirrel per acre. They are also found in cities and parks with large hardwood trees. They like to live in areas where there are oak, hickory, tulip tree, beech, maple, sassafras, and flowering dogwood. Timber management practices which create broken stands of middle-aged and mature trees provide the most food and den sites for them. They have both leaf nests and tree dens. Leaf nests are made of twigs and leaves, are 1 - 2 feet in diameter, and have an interior space 4 - 5 inches across. They often are near a grapevine growing up a tree. The dens are at least 20 ft. above the ground, in a hollow trunk or limb at least 15 in. in diameter. The den entrance is 3 - 4 in. wide; the hollow inside space is 2 -3 ft. deep and lines with leaves.
Growing Up: Squirrels grow up slowly. At about 7 weeks they begin to taste green food, bark, and other solids. Spring litters are often still together in late fall, at about 9 mo. old. They eat their own weight in food every week. They don't remember where they bury nuts and acorns, but use their good sense of smell to find them in winter. Because they don't find many of the nuts and acorns they bury, lots of these sprout and grow. The Eastern Gray Squirrel is a major tree planter in the hardwood forest. Note: Information for the Life History Notes above has been obtained from the Ohio Department of Natural Resources, Division of Wildlife's Publication, Life History Notes.

Life History Notes -- Great Horned Owl

Scientific Name: *Bubo virginianus*
Other Common Names: Hoot owl, king owl, eagle owl, cat owl, chicken owl, horned owl, Virginia horned owl, woods witch
Mating: Monogamous; peak activity in January
Nesting Period: Early February to mid-May
Clutch Size: 1-5 eggs; average 2
Egg Color: White to dusky white
Egg Shape and Size; roundly oval; 2.2 x 1.9 in (56 x 48 mm)
Incubation: 32-35 days; peak of hatch in early to mid-March
Young: Leave nest in 5-7 wks.; first flight at 9-10 wks.; resemble adults at 2 mo.; sexually mature at 2 yrs.
Number of Broods per Year: 1; rarely re-nests if disturbed
Adult Weight: Male, 2 1/2 to 3 1/2 lbs (1.1-1.6 kg.); average 3 lb. (1.4 kg.); Female, 3 to 4 1/2 lbs. (1.4-2.0 kg.), average, 3 3/4 lbs. (1.7 kg.)
Adult Body Length, Including Tail: Male, 19-23 in., (48-58 cm); Female 22-25 in. (56-64 cm).
Adult Wingspread: Male, 50-55 in. (127-140 cm); Female, 50-62 in. (127-15 cm)
Life Expectancy: approximately 50% of Great Horned Owls hatched will die during their first year. Surviving adults average 6-7 yrs.; Maximum age in wild is 15 yrs.; Captive birds have lived over 50 yrs.
Movement: Home range varies a lot according to season, habitat, and availability of prey; generally 1-6 sq. miles per pair. Great Horned Owls don't migrate. Young leave in fall, but generally locate within 30 miles of parents' territory. Northern birds may move south during severe winters.
Feeding Period: Mostly at night, but will also hunt by day
Foods: Most widely varied diet of all North American birds of prey; including rats, mice, skunks, bats, shrews, moles, squirrels, rabbits, cats and other mammals; also songbirds, gamebirds, waterfowl, hawks, owls, snakes, turtles, frogs, fish, crayfish, worms, and insects.
Description: It is the largest "eared" owl in North America. It is generally brown, spotted with darker brown, and heavily barred. The underparts are somewhat lighter in color, with a conspicuous white throat patch. The legs and feet are large; extremely well developed, and almost fully feathered. The great curved talons are thick at the base, tapering to sharp points, and can inflict severe damage. The large eyes are bright yellow and highlighted by a black facial rim. The sexes are identical in coloration but the female is bigger.
Living Areas: It can adapt to many areas where it can find suitable nest sites. Maximum densities occur in heavily forested areas, but open woodlands, orchards, parks, marshes, swamps, and lakeshores are also used. Note: Information for the Life History Notes above has been obtained from the Ohio Department of Natural Resources, Division of Wildlife's Publication, Life History Notes.

Life History Notes -- Muskrat

Scientific Name: *Ondatra zibethicus*
Other common names: Marsh rabbit, marsh hare, 'rat
Mating: Usually monogamous; sometimes polygamous
Breeding Period: February - August; peak activity - April
Gestation: 22 - 30 days
Birth Period: March - September; peak - May
Litters Per Year: 2 -3 ; usually 2
Litter Size: 1 - 11; average 6
Birth Weight: 3/4 ounce (21 grams)
Eyes of Young Open: at 15 days
Young Leave Nest: at 15 days
Young Weaned: at 4 weeks
Breeding Age: 10 - 12 months
Adult Weight: 2 - 5 lb (.9 - 2.3 kg) average 3 lb (1.4 kg)
Adult Body Length: 12 inches (30 cm)
Adult Tail Length: 10 inches (25 cm)
Life Expectancy: less than 2 years; maximum 4 years
Movement: home range radius 100 - 200 years (91 - 183 meters) from house or den
Feeding Period: mostly at night; often during day
Foods: stems, roots, bulbs, and foliage of aquatic plants such as cattail, burred, bluejoint grass, needlegrass, waterlily, pond weed, and sedge, also clams, snails, mussels, insects, crayfish, fish, frogs, and corn. Muskrats do not store food for the winter, and will eat dead carcasses of fish when ice interferes with normal feeding pattern.
Description: It is a stocky rodent with a broad head, short legs, small eyes, and short ears that barely extend above its fur - the fur is rich dark brown on the upper parts and silver-tipped on the belly; the guard hairs are long and coarse and the underfur is dense and waterproof. The muskrats naked, scaly tail - is flattened from side to side.
Living Area: It can be found wherever there are marshes, swamps, ponds, lakes, and ditches. It likes an area with still or very slowly running water with vegetables in both in the water and along the banks. Cattail, burreed, and bulrush marshes are ideal. Muskrats build their houses or dens from available vegetation. The watertight conical house may be six to eight feed wide and two to four feet tall. Along streams, and where water levels are low, some muskrats dig den burrows in the banks.
Protecting Itself: Muskrats are quarrelsome, especially when they are over abundant. When fighting, they may squeal, squawk, snarl, moan, and chatter their teeth. An overly dense muskrat population can severely damage its own marsh habitat, and may become prey to epidemic disease. Muskrats also have many natural enemies, including mink, weasels, foxes, snakes, hawks, and owls. The drainage and destruction of wetlands is their worst enemy. Note: Information for the Life History Notes above has been obtained from the Ohio Department of Natural Resources Division of Wildlife's Publication, Life History Notes.

Life History Notes -- Opossum

Scientific Name: *Didelphis marsupialis*
Mating: Polygamous
Breeding Period: January-October; February-March (peak)
Gestation: 12-13 days
Birth Period: February-November
Litters Per Year: 1-3
Litter Size: 5-25; average 9
Birth Weight: 1/15 oz. (1.9 grams)
Young Remain in Mother's Pouch: 2 mo.
Eyes of Young Open: at 2 mo.
Young Leave Nest: at 3 mo.
Young Weaned: 15-20 in.(38-51 cm.)
Breeding Age: 1 year
Adult Weight: 4-15 lb. (1.8-6.8 kg); average 5 lb.(2.3 kg.)
Adult Body Length: 15-20 in. (38-51 cm.)
Adult Tail Length: 9-20 in. (23-51 cm.)
Life Expectancy: 1-2 yrs.; maximum 7 yrs.
Movement: home range 15-40 acres (6-16 hectares), but individuals may wander widely, especially in fall
Feeding Period: Mostly at night
Foods: Omnivorous--carrion, insects, fish, amphibians, reptiles, eggs, fruits, vegetables, and nuts.
Description: Adults are about the size of a large house cat, with coarse, grizzled grayish fur, a long, naked, scaly tail, naked ears, and a pink nose at the tip of a long, pointed snout.
History: The opossum is the oldest and most primitive mammal in North America. Its ancestors roamed the giant fern forests 70 million years ago. It is small-brained, plodding, and unspecialized yet it has survived. The opossum wasn't common before pioneer settlement. Today it is very common. It prefers farmland, especially wooded pastures near a stream, lake, marsh, or swamp. It also lives in urban areas. It especially likes areas where there are mixed woods, wetlands, and farm land.
Living Area: Its den is usually in a wooded area near water. It can make a den in almost any place where it can stay dry and safe. It will use other animals deserted dens, brush piles, tree holes and openings under old buildings.
Development: The opossum is the only marsupial in North America. The babies are pea-sized and undeveloped. The newborn crawls blindly to the mother's pouch, climbs inside, and attaches to one of 13 nipples in the pouch and hangs on for 2 mo. so it is constantly fed. If a newborn doesn't find a nipple, it dies. At 3 mo. the young leave the pouch for short periods, hitching a ride on their mother's back.
Protecting Itself: The opossum will sometimes bare its 50 teeth and hiss loudly. Usually it rolls over and plays dead. Note: Information for the Life History Notes above has been obtained from the Ohio Department of Natural Resources, Division of Wildlife's Publication, Life History Notes.

Life History Notes--Ruffed Grouse

Scientific Name: *Bonasa umbellus*
Other Common Names: More than 100 names are recorded including pat, partridge, wood pheasant, mountain pheasant, and drummer.
Mating: Promiscuous; peak activity mid-April. The male Ruffed Grouse performs spring mating displays on a platform, usually a log, in a 10 to 30 acre activity center which he normally occupies all his life. Standing on the platform, he beats his wings, slowly at first, then ever faster to produce a "drumming," a hollow, low-pitched sound like an engine starting up at a distance.
Nesting Period: April-May; peak hatch in late May
Clutch Size; 9-14 eggs; average 10
Egg Color: Milky white to cinnamon buff, usually plain but often with reddish spots.
Egg Shape and Size: oval, 1 1/2 x 1 1/8 in (38 x 29 mm.)
Incubation: 1 - 24 days
Young: Leave nest when down is dry; first flight at 2 wks.; resemble adults at 16 wks.; sexually mature at 10-12 mo.
Number of Broods per Year: 1; if first next disrupted, may re-nest and lay about 7 eggs.
Adult Weight: 16-27 oz. (454-765 grams)
Adult Body Length, Including Tail: 16-19 in. (41-48 cm)
Adult Wingspread: 22-25 in. (56-64 cm)
Life Expectancy: Average about 1 year; maximum 8 years
Movement: Home range 20-40 acres
Feeding Period: Mostly in early morning and late afternoon
Foods: Young grouse eat insects and berries; adults eat parts of more than 100 wild plants including bedstraw, cinquefoil, avens, greenbrier, grape, dogwood, ferns, sumac, bittersweet, poison ivy, cherry, hawthorn, hophorn beam, blueberry, blackberry, raspberry, viburnum, oak, aspen, and hazelnut; they don't usually eat any cultivated crops.
Description: A large, chicken-like bird with a fan-shaped tail. They can be brown or gray. The black ruff on each side of the neck is most noticeable in the male. A black band, extending across and near the end of the tail, is interrupted with gray in most females and a few males. A fully developed central tail feather will measure (when plucked) more than 6 1/4 in. in 99% of males; it is usually shorter in females.
Living Areas: The Ruffed Grouse lived in the forests when the settlers came. When much of the forest was removed only small numbers of grouse survived. Ruffed Grouse are coming back to areas where forests are regrowing. They like stands of mixed species of hardwood shrubs, saplings, and brush-vine tangles. They also like moist areas with dense clumps of shrubs interspersed with lush herb growth. Finally, they like young forest stands of mixed hardwoods. They especially like areas with a stream or swamp. Note: Information for the Life History Notes above has been obtained from the Ohio Department of Natural Resources, Division of Wildlife's Publication, Life History Notes.

Life History Notes -- Striped Skunk

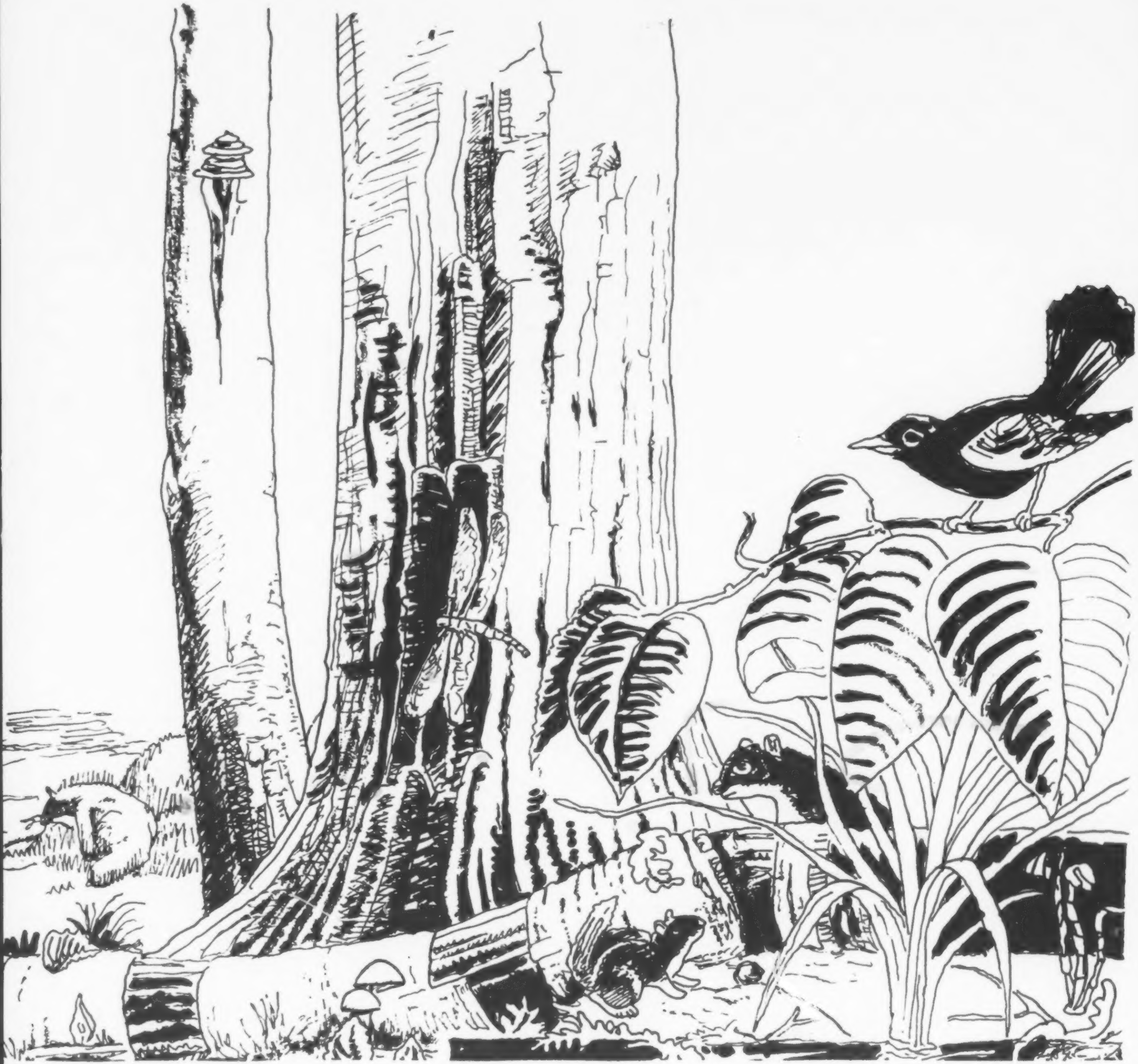
Scientific Name: *Mephitis mephitis*
Other Common Names: Polecat
Mating: Polygamous
Breeding Period: February-March
Gestation: 63 days
Birth Period: May
Litters Per Year: 1
Litter Size: 2-10; average 6
Birth Weight: 1 oz. (28 grams)
Eyes of Young Open: at 4-5 wks
Young Leave Nest: at 6-8 wks
Young Weaned: at 6-7 wks
Breeding Age: 1 year
Adult Weight: 6-10 lb (2.7-4.5 kg); average 8 lb. (3.6 kg)
Adult Body Length: 13-18 in (33-46 cm)
Adult Tail Length: 7-10 in (178-254 mm)
Life Expectancy: 8-10 yrs.
Movement: home range 10 acres
Feeding Period: at night
Foods: Omnivorous -- mice, lizards, frogs, fish, crayfish, insects, grubs, eggs, fruits, and carrion
Description: It is about the size of a house cat, with a large body, small head, and short legs. The hair is long and black, with a broad white patch on the head and shoulders. Two white lines forming a "V" from the shoulder area may extend part way or all the way to the base of the bushy tail.
Living Area: The Striped Skunk has increased in numbers as the forest has been cut down. It prefers a semi-open living area of mixed woods, brush, and open grassland within two miles of water. Its den may be in a ground burrow or beneath a boulder, rock pile, wood pile, or abandoned building. Almost any dark, dry, sheltered site will do. In December females den up, sometimes 8 - 10 to a den. Males are more solitary. During periods of extreme cold they may stay inside for days at a time, but a warm spell will bring them out in search of food. **Habits**: Young skunks are taught to hunt by their mother, and in late June or July are seen walking single file behind her at dusk, off for an evening's feeding and training. They make a variety of sounds; they can twitter, screech, growl, churr, coo, and whistle. They don't hibernate.
Scent: The Striped Skunk has well-developed scent glands, located at the base of the tail. When seriously threatened, the skunk can squirt the musk from these glands with great accuracy up to 15 feet. Even a gentle breeze can carry the scent more than a mile. The musk is yellowish, has an acrid, stinging odor, and sticks like glue. It is painful to the eyes. Tomato juice is the best treatment if you have been sprayed. Scented clothing is best burned. Note: Information for the Life History Notes above has been obtained from the Ohio Department of Natural Resources, Division of Wildlife's Publication, Life History Notes.

Life History Notes -- Wild Turkey

Scientific Name: *Meleagris gallopavo*
Mating: Polygamous; breeds in April
Nesting Period: April 15-June 15; hatching peak May 15-June 15.
Clutch Size: 8-16; average 12
Egg Color: Pale creamy white to creamy beige with small, pale chocolate or reddish brown spots
Egg Shape and Size: Oval, 2 1/4 x 1 3/4 in (57 x 44 mm)
Incubation and Development: 28 days incubation; leave nest in 24 hours; first flight at 2 wks.; look like adults at 16 wks.; females sexually mature at 1 yr.; males at 2 yrs.l 1 brood per year
Adult Weight: Male 8-24 lb. (3.6-10.9 kg.), average 17 lb. (7.7 kg.); female 7-16 lb (3.2-7.3 kg.), average 11 lb. (5 kg.)
Adult Body Length, Including Tail: Male 42-28 in. (107-122 cm); Female 32-38 in. (81-97 cm)
Adult Wingspread: Male 42-48 in (107-122 cm); Female 34-39 in (86-99 cm), average 37 in. (94 cm).
Life Expectancy: Male, average 2 yrs.; Female, average 3 yrs.; maximum 10 yrs.
Movement: home range 2 sq. mi.
Feeding Period: daytime
Foods: Acorns, beechnuts, dogwood fruits, grape, greenbrier, many other shrubs; insects; leaves and fruits of many herbaceous plants
Description: An upland gamebird, its 3-4 ft. tall and weights up to 24 lbs. It has a slim build, long neck, and nearly featherless head. The body feathers look drab brown from far away, but are iridescent when seen close up in good light. The large tail is brown with a black band near the tip. Adult males (gobblers) have a reddish head; a long, tasseled "beard" dangling from the breast; black-tipped breast feathers, and spurs on the legs. Hens have a bluish head, usually no beard, buff-tipped breast feathers, and no spurs.
Living Area: Wild turkeys were found all over eastern forests before settlement. Hunting and cutting down of forests eliminated them from many areas after settlement. Turkeys have been reestablished as forests have regrown. An average of two turkeys per square mile is found in the spring now. Turkeys prefer mature forests and don't like much disturbance from humans. Note: Information for the Life History Notes above has been obtained from the Ohio Department of Natural Resources, Division of Wildlife's Publication, Life History Notes.

STUDENT HANDOUT 3

Forest Processes



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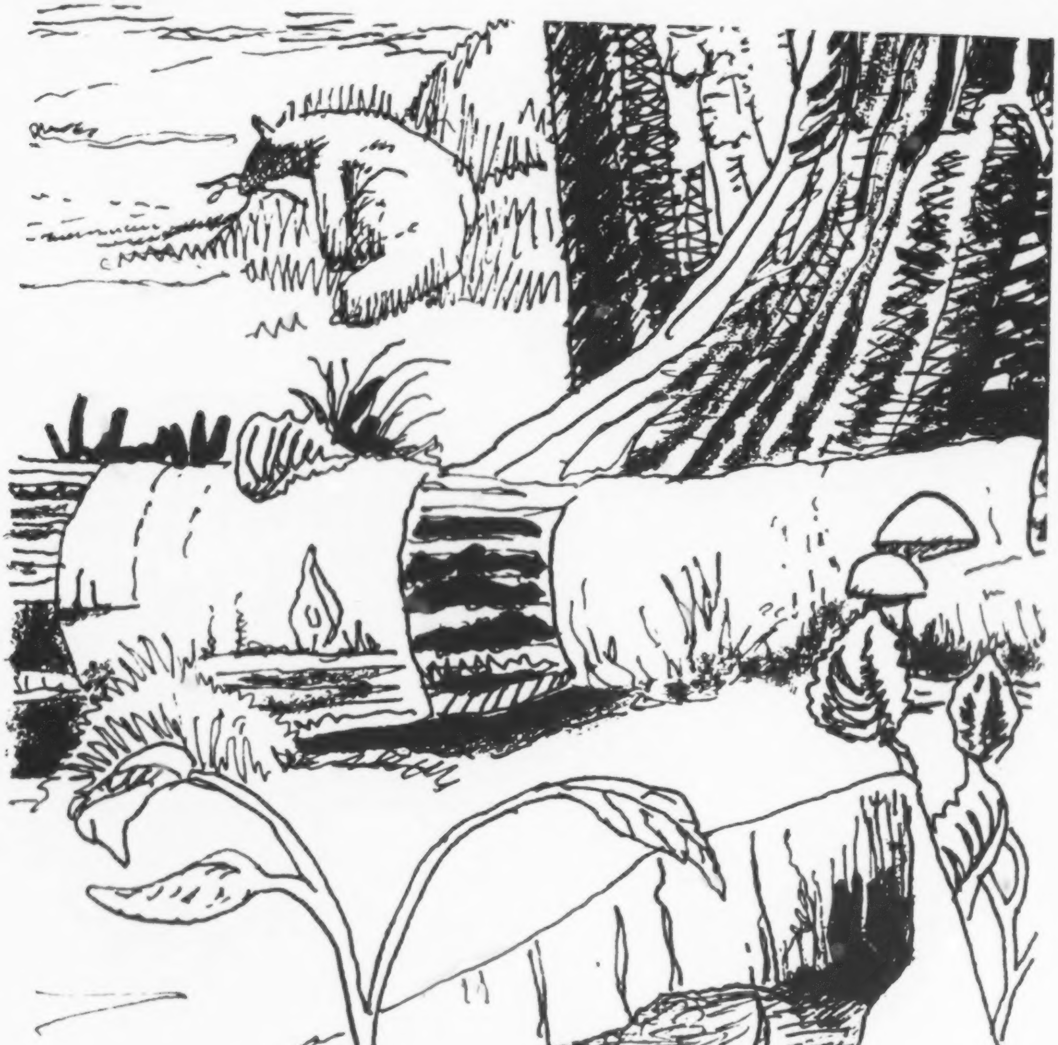

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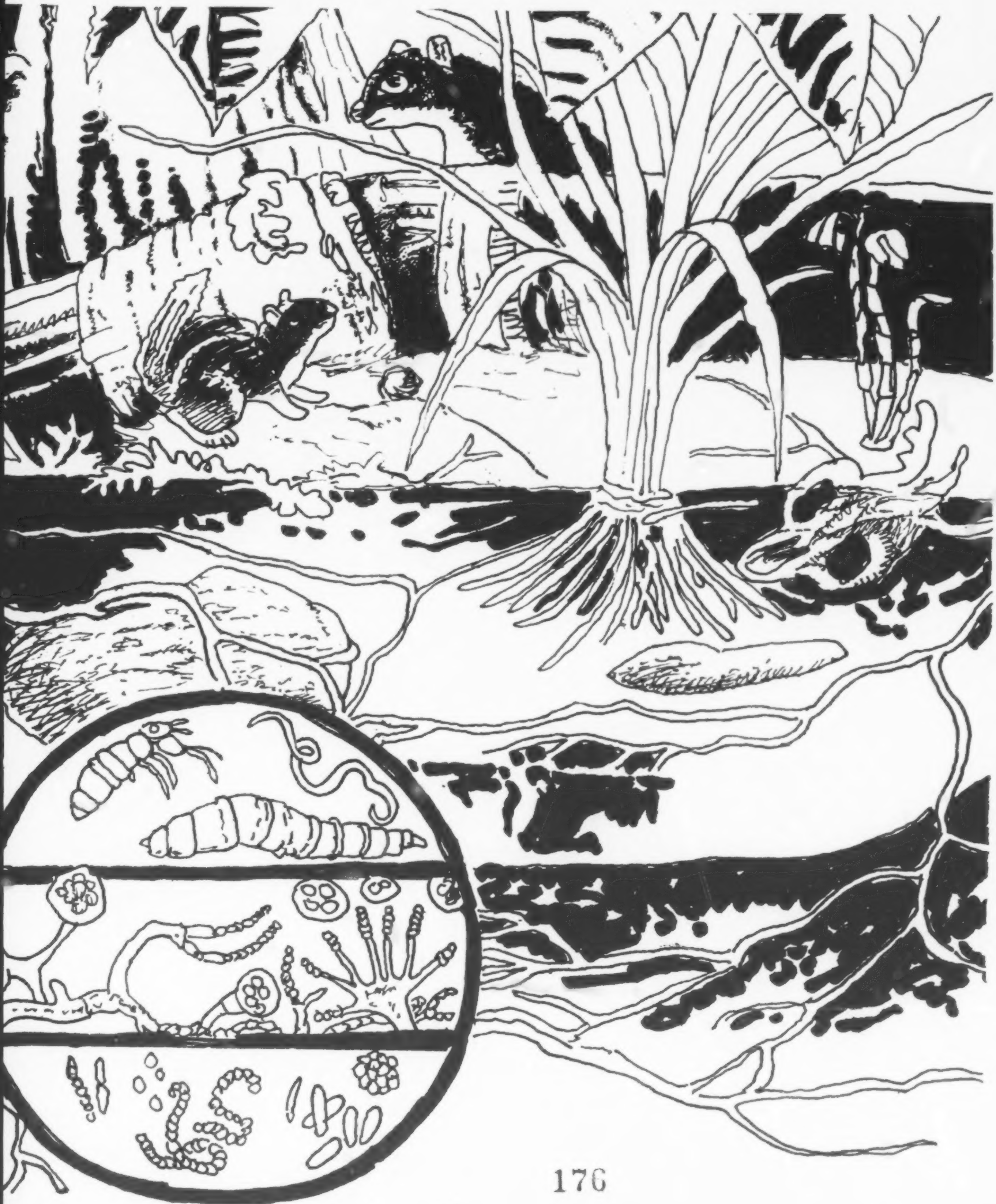

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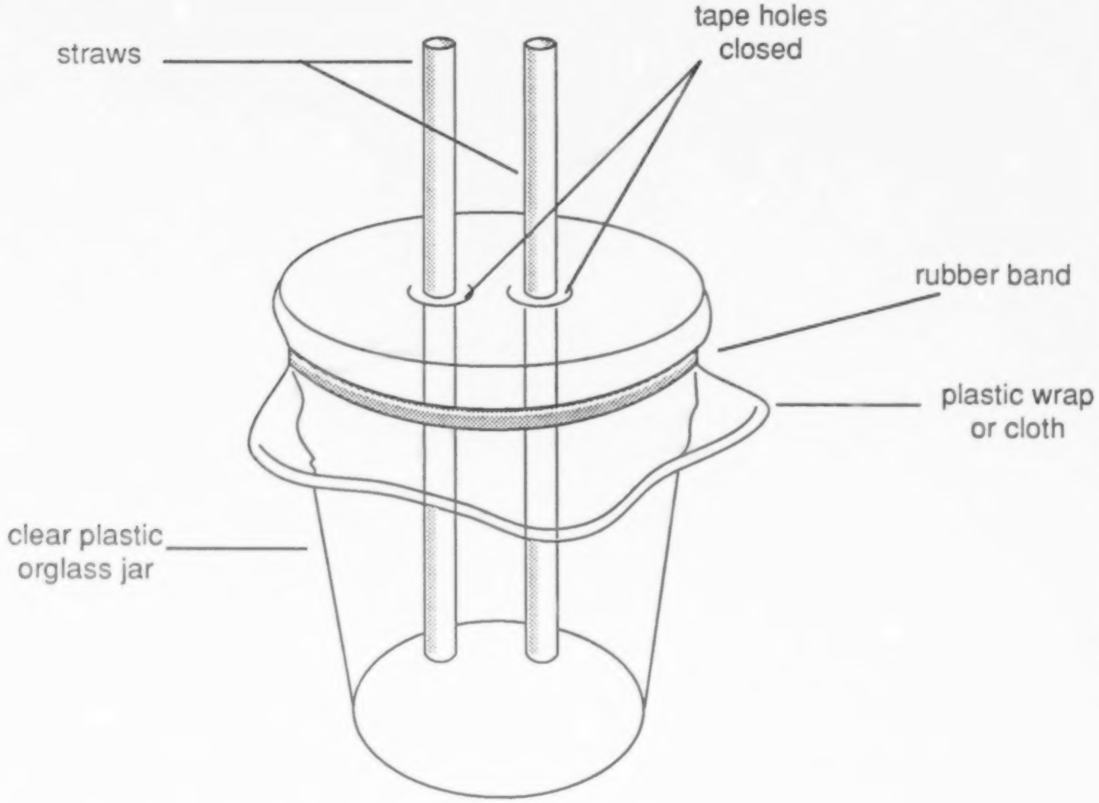
Student Handout 4

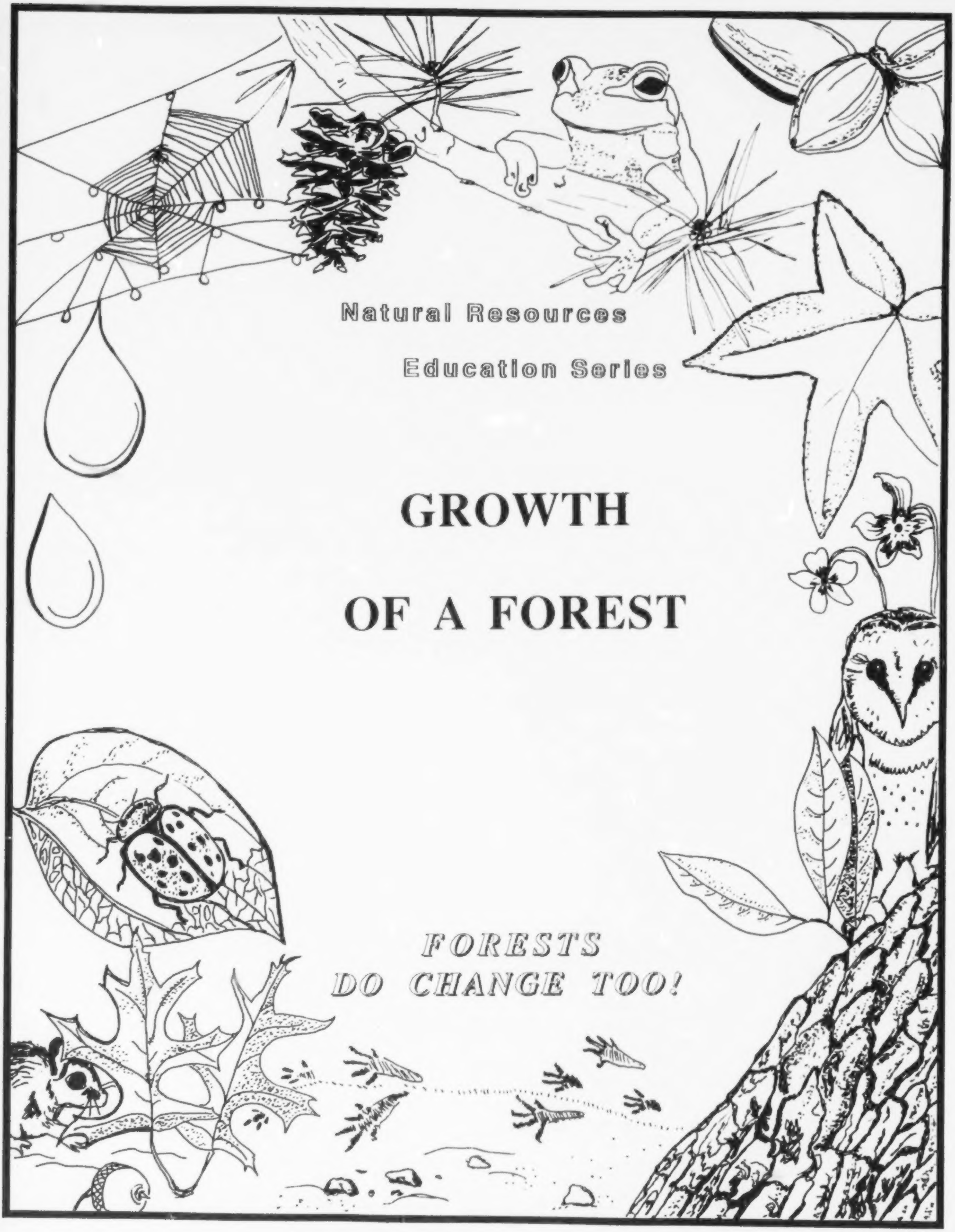
Directions for Making a "Pooter"

You will need: one glass pint jar, 2 plastic straws (preferably those which bend) plastic wrap, tape, a piece of thin cloth like an old sheet, scissors and rubberbands.


straws
tape holes closed
rubber band
plastic wrap or cloth
clear plastic orglass jar

Directions:

!. Cover a glass jar with a piece of cloth or plastic wrap.
2. Use a rubber band to stretch the cloth over the glass and to hold the cloth on tight.
3. Make 2 small holes in the cloth and insert a plastic straw in each.
4. Use tape and/or plastic wrap to fill in space between cloth and straw so what you catch in the pooter can't crawl out through this space.



Natural Resources

Education Series

GROWTH

OF A FOREST

FORESTS
DO CHANGE TOO!

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The writing, development and, production of the *NATURAL RESOURCES EDUCATION SERIES* is a joint project with collaboration of project directors Dennis W. Sunal, The University of Alabama, and Mary E. Haas, West Virginia University, and the U.S. Forest Service. Partial funding was provided by the U.S.D.A. Forest Service. The initial author and series editor was Dennis W. Sunal. Revision of individual modules was carried out with the help of Mary E. Haas, and Cynthia S. Sunal. Assistance in creating appropriate activities, proof reading, and creating art work by computer for the many editions was provided by Jon Berninzoni, Elwin Dickerson, Tracy Johnson, Jane McGinnis, and Sukhwindar Singh. Final editing assistance on the text and artwork was performed by Audrey Rule. William Kline, Jr. assisted in training the original trial teachers. Content reviewers were specialists in the various module topics at the U.S. Forest Service including Monongahela National Forest staff members, Theresa Anne, Randolph Harrison, Linton Wright, and Harry Mohoney, and Northeastern Forest Experiment Station, Timber and Watershed Laboratory staff Pamela Edwards, David Helvey, James Kochendorfer, and Clay Smith. Teachers in the Randolph County, West Virginia Schools who first taught the modules and made recommendations for revisions were: Sandra Arbogast, Sara Basil, Ann Deloach, Karen Hall, Richard Leitner, Elizabeth McDonald, Linda Moore, Sharon Moss, Pam Mullennex, Jeff Ranhart, Theresa Skidmore, Rachel Snavely, Charles Swecker, Nancy Taylor, Angela Vance and Rebecca Wallace.

The *NATURAL RESOURCES EDUCATION SERIES* is designed to supplement textbooks with active learning lessons for students in the primary and middle childhood grades (K-8). The series consists of Understanding Our natural Resources Teacher's Guide and 12 Modules including Appreciation of Natural Beauty, Soils and Plant Growth, The Water Cycle, Natural History of a Tree, Recipe for Tree Growth, Tree Growth and Environment, Forest Processes, Managing Our Forest Resources, Growth of a Forest, Interactions of Forest Plants and Animals, Natural Watersheds, and Managing Our Natural Resources.

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GROWTH OF A FOREST

GROWTH OF A FOREST

FORESTS DO CHANGE TOO!

BACKGROUND INFORMATION FOR TEACHERS

Plants in the forest setting are affected by their environment. These same plants in turn influence and change this environment. The forest environment can be changed to the extent that some plants, trees, may not compete successfully and disappear from the area. Animals change as well as plants in this process. Since animals depend on plants for food and cover, an animal habitat, a change in plants in an area will favor some animals over others. In turn, the number of animals of a specific type will change. This instructional module would fit with science textbook and teacher prepared chapters and units involving topics such as where specific plants (and animals) live, animals and plants are important, food chains and food webs, predator/prey relations, succession and ecosystems. Advanced preparation is needed for this module. The teacher should read ahead and plan accordingly.

A group of plants and animals that live in the same area and dependent on one another for food and other requirements is called a community. The many species that make up plant and animal communities and the specific geographic locations of plant communities have changed over time. Forests once occupied the areas where southwestern deserts now exist. Prairies once covered large portions of Illinois, Indiana, and Ohio. Palm trees once flourished in Greenland and many areas that are now dry land, were once at the bottom of the ocean. Such marked changes in the vegetation of an area result from major climatic and geological changes. Considered from a long range geological standpoint, major changes in the vegetation cover of the earth have also been due to plant evolution.

Replacement of one plant form by another usually occurs gradually in successive stages. Thus, this process has been called succession. This term is frequently used for somewhat less marked and dramatic changes in the plant and animal communities. The most basic type of plant succession occurs when there is bare rock or soil in an area that can be invaded by plants. Natural or primary successions may begin on rock outcrops or on land formed by the silting in of ponds or lakes. Natural succession occurs in established communities of plants and animals. Secondary successions occur when land that people have cleared is allowed to grow back to natural vegetation.

Changes of abandoned crop land to forest are not haphazard. They are orderly and predictable, barring disturbances by humans or natural events. The change in species composition of the community over this time is called ecological succession.

Each growth phase is a point on the continuum of growth in the area and is recognizable as a distinct community with its own composition of index species. Successional stages include primary, secondary, and climax. Rocks and cliffs are the most common terrestrial primary sites. Lichens and mosses colonize the bare surfaces of rocks. Gradually soil accumulates in cracks and depressions. This leads to greater soil moisture which supports more plants and produces more soil organic matter. These changes in condition favor germination of several types of plants. Grasses, in addition to more mosses and herbs, move in on deeper soil islands. Low woody plants may follow, but extreme stress caused by lack of moisture in the soil during drought can cause high mortality of such plants cutting down on woody growth each dry season.

Human industrial operations can leave denuded land, creating primary succession sites. These primary sites include surface mined lands, for example coal surface mines, on which the soil has not been reclaimed. The upper layers of soil were taken away or buried. Unreclaimed surface mine soils often are comprised of unweathered rocks or gravel. Revegetation may begin within three years (depending upon conditions - it may take much longer) involving species whose seeds are transported by animals or wind, such as grasses and blackberries.

We most often see secondary succession on abandoned farmland and non-cultivated waste places such as landfills, spoil banks, railroad grades, and roadsides. Initial species most frequently found in such places are grasses, goldenrod, and other herbaceous plants. Later, brush species invade the area causing weed plants to eventually disappear due to competition for light, moisture, nutrients and growing space. Examples of brush include blackberries, sumac and hawthorn. Groupings of plants such as these are often called index species because they typify a particular stage of succession for an area. Following this initial "brush" growth, plants such as fire cherry and pine begin to grow. A new group of index plants now exist. As time moves on, forests of maple, hickory, oak, or pine may develop. Thus, over a period of years, one community replaces another until a relatively stable forest or climax community of plants and animals finally occupy the area.

The climax community of an area is usually a mature and developed forest. This community is relatively stable and may exist for a very long time, but it must not be thought of as permanent. Climates change and the ecological communities must respond to these climatic shifts. For example, the North American climate has been experiencing a gradual warming trend since the last retreat of continental glaciation about ten thousand years ago. Current climax communities then, will experience gradual succession upon reaching maturity, in response to this warming trend, with gradual replacement by a young, different community that is better suited to the new conditions. Storms and diseases increase the likelihood of accelerating this process.

OBJECTIVES: Choose those appropriate for your students.

-Observe different successional stages of plant/forest growth.

-Identify successional stages (primary, secondary and climax) of plant/forest growth.

-Graph/chart various growth attributes of succession.

-Identify local land areas where primary and secondary growth may be occurring.

-Identify and classify some plants (or index plants) found in primary and secondary growth areas in local and other environments.

EXPLORATION PHASE

TO THE TEACHER:

The initial phase of exploration involves interactive activities using observation and other science process skills to help students, on their own, to discover basic concepts and relationships in the growth of the forest. The teacher should use this time to organize groups, observe interactions, and permit students to investigate possibilities themselves. Students should be asking questions, gathering first hand information and making connections to their previous experience in and out of school. Ideally the student should be confronted with a problem or event which cannot be explained by past knowledge.

EARLY CHILDHOOD ACTIVITIES

Materials: for each group

- flip charts, see Student Handout 1. Some preparation is required. For better results each flip book should be contain double the total number of 12 pictures. This will slow down the change process. Instead of sequencing pictures as 1,2,3,4..., use 1,1,2,2,3,3,4,4 ... as a sequence.

Involve the students in the following activities:

1. Introduce the succession concept using flip charts (pictures) depicting tree/forest growth or use still pictures showing forest growth at different times.

2. The discussion following the activity should center on what would happen if one or two picture segments were left out or others added.

3. Allow students to describe, suggest and/or try out other examples of sequence, the school day, an action sequence such as making up a bed or their own growth.

MIDDLE CHILDHOOD ACTIVITIES

TO THE TEACHER:

Students will be grouped in 2's and 3's to observe, record, discuss and analyze, developments in a given picture set or local area outside of the classroom. Assign each with a specific role.

This same activity could be carried out on the school grounds if a sunny wild area could be set aside from any disturbance. Each year clear out of a small area all plants and visible roots. The area may be as small a one square meter. You may want to turn over the soil with a shovel. After a few years, if left alone from any disturbance, these areas would represent a plant succession pattern.

Materials: For each group
- transparency or student copies made of Figure 2
- pictures of the same forest area taken at different times, see Student Handout 2
- student recording sheet, see Student Handout 2, page 2 and 3
- graph paper, 1/4" or smaller squares or
- graph paper, 1/2" or larger squares

Involve the students in the following activities:

1. Introduce the basic plant groups, if students are not familiar with them. The plant groups may be as simple as mosses/lichen, weeds (grasses and other flowering plants), bushes and trees. Ask the student groups to record observations from each of the six pictures. Figure 1 below presents one way to record data. A student version can be found in Student Handout 2. You may design your own to fit your students' needs. Following the observations the groups can report on all of the pictures to the whole class.

Figure 1
Report Record for Pictures

	rocks/soil mosses	**weeds**	**bushes**	**trees**
Picture 1				
Present (?) yes/no	_____	_____	_____	_____
Identify or Describe				

2. Distribute Student Handout 2 (3 pages). Tell the students that each picture was taken near the same location, but years apart. Picture 1 depicts an initial stage of growth after cutting a stand of trees. The first two photos show pioneer plants, the first plants of a new successional stage to invade an area, and other species.

3. Ask students to list on a recording sheet their observations from the first picture.

4. Ask students to observe and interpret the second "picture". Ask them to classify this as well in the same manner.

5. Repeat with the rest of the six pictures.

6. Ask the students to compare records and discuss what occurred in their groups.

7. Ask the students to construct a graph of the number of bushes or trees seen in each picture. Other features could be graphed if present in enough detail, for example diameter of trees. Different groups can graph different items in the picture. Show one or both graphing patterns in figure 2 on the blackboard, or with a transparency, to help students begin. Discuss the different graph formats. Using a bar graph technique the same results may look like figure 2. Dark bars represent a particular tree and the light bar represents a particular bush. Pass out graph paper.

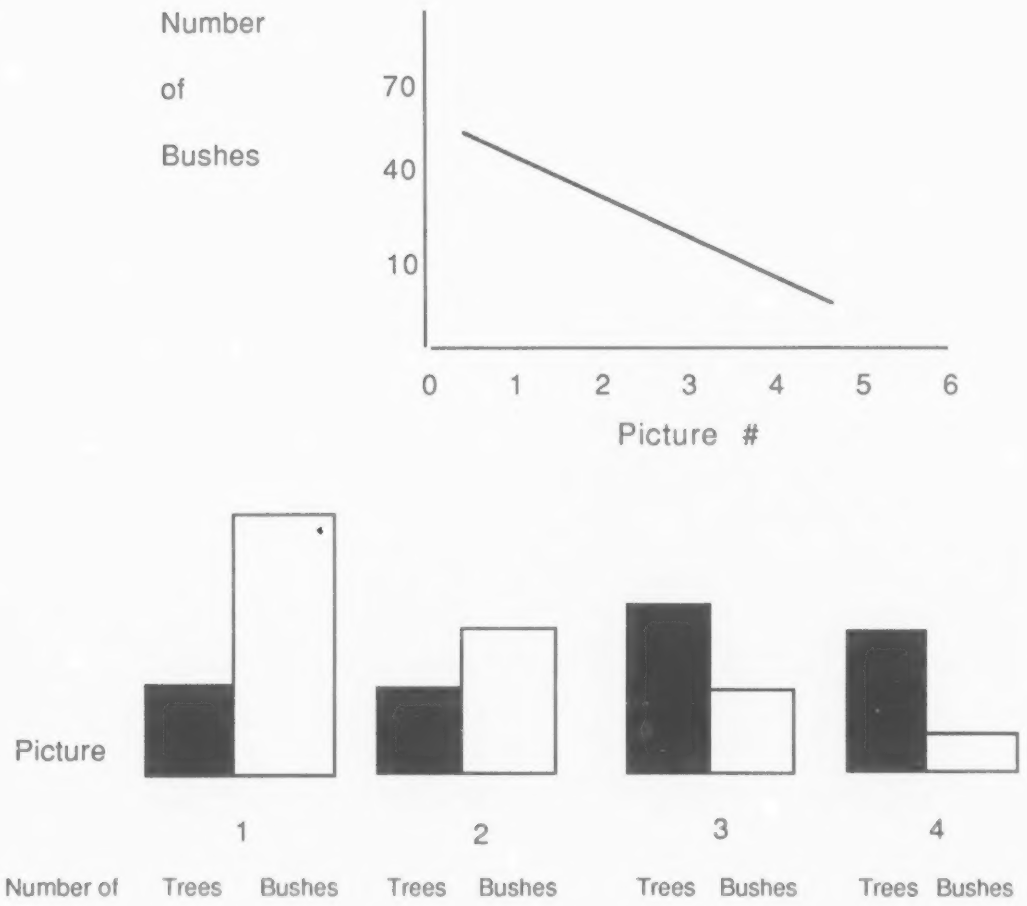


Figure 2
Examples of Different Graph Formats to Use With Pictures

Discuss the results in small groups and with the entire class. Increases and decreases can be found over time. The important idea that students could discover on their own is that change does occur and this similar change can be found in other areas in the same region. The sequence would be similar given the same environment.

INVENTING THE IDEA PHASE

TO THE TEACHER:

During this phase of the learning cycle, the teacher will play a more directive role. At this time the teacher may wish to refer to notes, background information, etc. The teacher may use student activities to reinforce exploration activities in addition to demonstrating and explaining some of the ideas involved in the growth of a forest. Students who were not able to answer the problems or events given in the exploration should be led to an appropriate response at this time.

EARLY CHILDHOOD ACTIVITIES

Materials: For each group
- Student Handout 3 for illustration purposes
- drawing materials such as crayons, magic markers and drawing paper. Modeling clay may also be used.
- copies of the play, OUR WONDERFUL FOREST, for student readers

Involve the students in the following activities:

1. As you begin the **Invention** phase of the lesson summarize the events in the flip books used in the **Exploration**. A rocky area with much bare soil, in frame 1, gradually becomes covered with grasses, mosses and small bushes. This is followed by tree growth with successive dominance, importance, of differing tree types. Small bushes and trees are gradually replaced by pines. Pines are gradually replaced by hardwoods in the last of the 12 frames. You might illustrate some of this discussion with pictures found in Student Handout 3 at the end of this module.

2. Have the students present an original play/skit illustrating and describing the growth of a forest. You may want to perform the skit/play for other classes too.

Characters:

Grandparent "Sugar-Sap" Maple - THE OLD TREE STORYTELLER as a teacher role

Little Tough-Bark Maple - student role

Little Flutter-Leaf Maple - student role

Little Sweet-Stem Maple - student role

Little Chunky-Trunk Maple - student role

OUR WONDERFUL FOREST - A Play Beginning

(Sample Story - The teacher may use this story or compose another more suitable to your students)

All grandchildren maples ask a question, "How did our forest home get to be so wonderful?"

("Grandparent Sugar-Sap Maple" gathers little Maples around to tell the story of how the forest came to be. What does the old tree tell them? Here the teacher should engage students in the task of constructing dialogue and appropriate actions).

G. Maple: Oh my quivering samaras, my girth is broad but the inside is old.

All Maples: Grandparent Maple, you are sooo big! Will we ever grow as strong and tall?

G. Maple: If the sky is bright, the rain a plenty and the earth good to you, perhaps. My, oh my, have I been lucky! I've seen many fellow maples leave this mountain. Often I've wondered how I was overlooked.

Little Chunky-Trunk Maple: But Grandparent Sugar-Sap, did you want them all to leave?

G. Maple: No, No, but that's the way of the forest - especially so in my last one hundred fifty years.

All Maples: Grandparent Sugar-Sap, we love to hear the wind whistle through your branches and leaves - please tell us about this forest when you were a sapling like us.

G. Maple: Oh yes, it's not hard for me to remember my first scarlet leaves during my first autumn on the mountain. I had landed in good loam the previous spring as a samara from my parent, a slender sugar maple.

Little Sweet-Stem Maple: Grandpa, what's a samara?

G. Maple: Well, Little Sweet-Stem, it's the beginning of any maple, a seed with wings. In our family we all - every one of you - began as a samara. Our very beginnings are tucked safely and tightly in this little fruit that grows from out parent tree. We are carried to a safe growing place by the wings of the brown samara.

Little Tough-Bark Maple: Then what happened?

G.Maple: Luckily a gentle breeze blew that spring, sparing me from hardship. I landed in rich loam and rain provided a lovely sweet drink that helped me grow.

Little Flutter-Leaf Maple: What's a loam? Did we grow in loam?

G. Maple: Why yes, look at you, strong and straight little saplings. You began close by where I started, here in soils made rich by years of the scarlet leaves I shed. You were nourished by loamy soils that took years to create; a nice mixture of decayed leaves, clay, silt, and sand. Look down your trunk to your bases, rustle your branches to blow away the top puff of whole leaves - blow! Blow hard now, do you see it? There! A nice rich nutrient-laden soil.

Little Flutter-Leaf Maple: Tell us more! What about the others, you're the oldest on this mountain now.

G. Maple: Well bless my furrowed bark! I could go on forever, I've been standing here for nigh on to 200 years. Yes, I grew with fellow seedlings that first growing season. We were all equally nourished and had a fine open sunlit home where there was nothing to reach for but the crystal blue sky.

There were red maple, mountain maple, black maple and many of our clan, the sugar maples. As time passed we grew well that first year as sapling (only 4 inches wide then) youth. Early that fall the axes rang as the breezes fluttered our bronzing leaves. With a few swoops many old timers left the forest to provide cabins for pioneer spirits who were blazing trails to the territory. Many of our young friends left to become permanent parts of those homes.

Little Chunky-Trunk Maple: Why weren't you taken?

G. Maple: I was too close to the cliffs to have been trampled or cut for use.

All Little Maples: (Chiming) Hurrah! Hurrah! Hurrah! We love Old Sugar-Sap!!

Little Sweet-Stem Maple: Please go on.

G. Maple: Needless to say life became more difficult as axes continued to ring through the air. We grew to see the land change to farms but our home here was protected. Tornadoes and harsh weather kept some trees from growing well. As some of us grew the others were crowded and their growth was stunted. My leaves provided shade for young plants unable to grow well in bright sunlight and our family of trees became this forest. I bear the scars of survival - look at this knob. It's where a barbed wire fence was tacked to my side. Eventually scar tissue grew around the open wound leaving the wire deep inside.

Little Maples: Ooo!

G. Maple: Also, a storm broke the branches on my lower side. Other trees were blown down at that time. After that I grew a bit unevenly. I survived and this open space created by the storms provided a place and home for all my lovely little children maples.

Little Maples: Yeah! for our grandparent, Old Sugar-Sap!

G. Maple: Yes, I have seen many lovely forest trees grow, be harvested, and make places for you and other growing saplings. There are many stories left but soon it will be winter. We all must rest. We can continue with these stories in March and April when these woods will be alive again with laughing hopeful signs of growth. We will see the silver maple with greenish red flowers, coltsfoot, spring beauty, fawn lily, solomon's seal, mayapple, violets, oaks and all of our old colorful friends.

Little Maples: Thank you sleep well.

1. Ask groups of students to illustrate different parts of the play/story. They might use crayons, markers or modeling clay.

2. When they are finished put the pictures together as a play illustration. Discuss the sequence with the students.

3. Provide a closure to the *Invention Phase* by briefly defining successive growth concepts and growth attributes of succession as related to time. Briefly illustrate them with a review of the experiences above.

MIDDLE CHILDHOOD ACTIVITIES

TO THE TEACHER:

Succession can be introduced through pictures, slides, filmstrip, transparencies and lecture but perhaps more graphically through a field trip to a local school or community site. Transportation may not be required. An excellent way to approach this part of the lesson would be to show an old photo and then visit the site after many years of growth and change.

Forest productivity increases as succession proceeds. Succession through many stages improves the efficiency of transfer and use of energy and nutrients. That is as maturity progresses structure, complexity and organization of an undisturbed ecosystem increases with time. See Student Handout #2, page 2.

The diversity of plants and animals also changes as succession moves toward maturity, but decreases in the climax stage. Increased diversity comes about largely through increased number of species while the total number of individuals in each successional stage remains about the same. Plants and animals which do compete against one another can exist together.

Early successional stages, primary and secondary, are characterized by low growing plants that have short life cycles. They are relatively small in size and reproduce annually by seeds or send out new growth from buds near the ground. In later successional stages taller plants have a competitive advantage, although this advantage may be gained by some form of external disturbance that reduces the vitality of early pioneer species. Succession can be considered as an expression of differences in colonizing ability, growth needs, and survival of organisms adapted to a particular set of conditions as the environment changes.

Materials: For each group
- transparencies or student copies made of figure 3 and Student Handout 3
- *Student Handout 2 , page 2 and 3, or similar student recording worksheet*
- *small bottle with screw top filled with distilled water*
- *small microscope*
- *a small quantity of pond water, dropper, dried grass*

Involve students in the following activities:

1. Describe the following as an introduction to the following activities.

   The Cranberry Glades wilderness in south central West Virginia is an excellent example of a series of successional stages. This wilderness comprises a 36,300 acre area. The once logged and eroded basin within the wilderness area is called the Cranberry Glades botanical succession. This bog is an initial way to integrate the idea of succession.

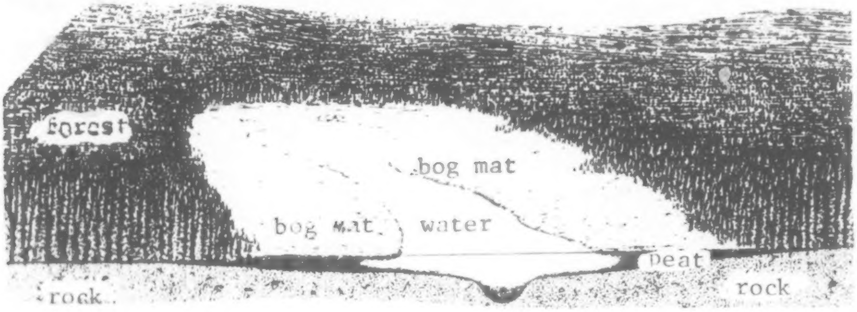
   Unglaciated regions of West Virginia with hard rock formation near the surface which may impede drainage of mountain streams may become bogs. Bogs usually and characteristically have a continuous carpet of sphagnum moss over a layer of dead loosely compacted peat. These layers may become very thick, 15 or more meters. Sphagnum bogs, such as these in West Virginia, represent an early stage in the primary succession leading to coniferous forest and eventually to a climax northern hardwood forest of oak and maple. Figure 3 shows a cross section of a bog over time. Open water changes to floating mats of sphagnum moss and finally to thick layers of peat.

Figure 3
Successional Stages of a Bog Area

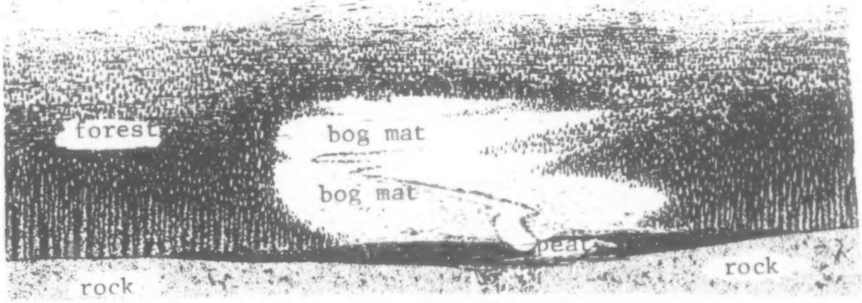
Flora found at Cranberry Glades:

surrounding area	bog area
spruce	round-leaved sundew
oak	large cranberry
hickory	small cranberry
	creeping snowberry
	skunk currant
	sphagnum moss
	sedges
	orchids

Cranberry Glades two thousand years ago



Cranberry Glades today



2. While illustrating two stages of development of a bog, make a transparency of Figure 3 as found in back of this module, ask students;

   a. How did Cranberry Glades look several thousand years ago?
   b. We know mountain streams flowed into the bog area. How do you think these areas changed over the years?
   c. How would you expect this area to look several thousand years from now?

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d. How would you compare changes here with successional changes on a deserted lot in a city or town?
e. What would some of the first plants to invade an area be?

Show successional stages can be different for various locations. Use pictures, slides or transparencies. See Student Handout 3 at the end of this module. Show examples of each stage from primary through secondary to climax.

3. Discuss each stage and identify key index plants. Ask students to compare these results with their previous notes from the exploration.

4. Discuss secondary and climax succession in the same manner. Compare with previous notes again.

5. *Optional: Take students on a field trip to a cleared site adjacent to a forested area, perhaps within walking distance from your school. A stand of trees on the school grounds may be appropriate.*
   A. *Give students a blank checklist worksheet of plants found in the area similar to those found in Student Handout 2.*
   B. *Ask students to complete out the checklist of plants in a,*
      1) *cleared area*
      2) *area directly adjacent to a stand of trees and*
      3) *a wooded area or a stand of trees with undisturbed ground plants.*

   Have students compare differences in plants in the 3 areas and discuss the differences found.

6. *Optional: (Perform this classroom experiment over a few days.) Make a "hay infusion" by boiling a few pieces of dry grass stems in distilled water. Inoculate the infusion with a few drops of water from a pond. Examine the infusion once each day with a microscope. The students should draw and record the succession of organisms that occur in the infusion over time. What organisms are new? List the types observed at regular intervals. How is this similar to plant succession in forests.*

7. Provide a closure to the *Invention Phase* by briefly defining successive growth concepts of primary, secondary and climax stages, index plants and growth attributes of succession as related to time. Briefly illustrate them with a review of the experiences above.

EXPANDING THE IDEA PHASE

TO THE TEACHER:

In the final learning cycle phase the student must use and apply facts, concepts and relationships concerning growth of a forest. Students should refer to previous cumulative information, notes, pictures, etc. New contexts and different ways of looking at the ideas explained in the earlier parts of the lesson should now be attempted.

Following expanding the idea, the teacher should check student outcomes with a quiz, performance test, and/or oral discussion.

EARLY CHILDHOOD ACTIVITIES

Materials:

- art materials (type and amount will vary)

Involve the students in the following activities:

1. Ask students to illustrate other sequenced events of which they are aware. These can be done with paint, crayon, cut and paste etc. Examples are human growth, puppy to dog, kitten to cat, egg to hatchling to chicken, growing grass from seed or change in the city or town over many years.

2. Let students tell their stories while they illustrate it.

3. Take the students on a short walking field trip around the school. In a natural area, stand of trees or open field, ask students to describe the changes which took place or will take place over a long period of time to illustrate an example of succession. Help the students if they cannot get started. Use drawings and photos to illustrate other examples.

MIDDLE CHILDHOOD ACTIVITIES

TO THE TEACHER:

In the eastern deciduous forest region of the United States, succession on a bare rock surface generally begins with lichens, mosses or crevice herbs and passes gradually through perennial herb, shrub, and pine stages to a oak-hickory forest and finally to a climax beech-maple forest (see Student Handout 3). In some areas hickory forests are the climax community. In more northern areas balsam fir, white pine and eastern hemlock trees represent some of the index species of a climax community. In southern areas shortleaf pine, longleaf pine and loblolly pine are some of the index species of a climax community. Baldcypress and tupelo represent some of the index species of a climax community in southern bottomland areas. Remember many other plant and animal species associated with these index plants form the total forest community. A successional change is made possible by the gradual modification of environmental characteristics. Such a change might be soil depth and richness of the soil as the rocks are eroded and weathered and as each successive community contributes humus to the soil.

As a pond or small lake begins filling in along its banks, bulrushes and cattails become established and contribute to further filling and holding of the soil. This process leads to conditions favorable for sedge swamps. As soil building progresses alders, willows, wild roses, and other plants invade the area, to be followed by an elm-ash-soft maple forest. Ultimately when the soil building process is complete and when the soil has attained good enough aeration the climax beech-maple forest becomes established. Every succeeding community changes the environment in ways that make it more suitable for the next community in the series.

Materials: for each group;
- photo of a bare ground area or see Student Handout 3 at the end of this module
- graph paper
- a long piece of craft paper (6 feet).
- color felt pens or colored pencils.
- Student Handout 3

Involve the students in the following activities:

1. Imagineering: Students will observe information from photos or other descriptive sheets for a prescribed area.

   A. Based on a forest photo of an area ask students to draw a mural showing a series of scenes demonstrating forest succession.
   B. Ask students to plot the hypothetical growth for a given area from barren soil to climax forest with a few select species. Plot /graph the number, diversity or other variables.
   C. Ask students to research specific areas in their region or state that have experienced succession stages after fire, gaps opened (treefalls), or use as grassland or timber harvesting. Contact the local soil conservation service, U. S. Forest Service or state forestry service for information, guest visits, or descriptive materials.

2. Ask students to explain the differences observed in vegetation as one walks away from a sandy shoreline of a lake. Pass out Student Handout 3 found at the end of this module to each group or show as a transparency. Ask each group to discuss the problem and write and illustrate their solution to be shared with the rest of the class.

   Student responses should be compared to the fact that it takes about 1,000 years for shoreline vegetational communities to colonize newly exposed sand beaches around a large natural lake, not man made and recent, (1) and finally develop into an oak forest (6), successively older sand dunes, plant communities change from grass (2), to shrubs (3), cottonwood (4), jack pine (5), and, finally, to the oak forest.

   As an alternate activity, you might suggest that students look at periods 1, 2, 3. Then draw or predict periods 4, 5, 6 (fold 4, 5, 6 projections back first).

3. *Optional: Take students to a cleared area adjacent to a forest or tree stand on the school grounds. Ask students to identify types of woody plants seen in the forest. Have them compare the lists. Ask them to predict growth in the cleared area if left undisturbed and predict possibilities of growth/regeneration if the cleared area is a) left undisturbed or b) disturbed by fire.*

4. *Optional: Divide students into groups. Ask each group to graphically represent:*
   a) *forest succession from bare ground to climax in their local area. They should include*
      1) *initial stage,*
      2) *pioneer stage,*
      3) *primary stage,*
      4) *secondary or climax stage.*

   or

   b) *pond succession from initial bare ground depression, to stream marsh and finally to ground covered by forest in their local area. Try to identify a specific area near the school to make the activity more concrete.*

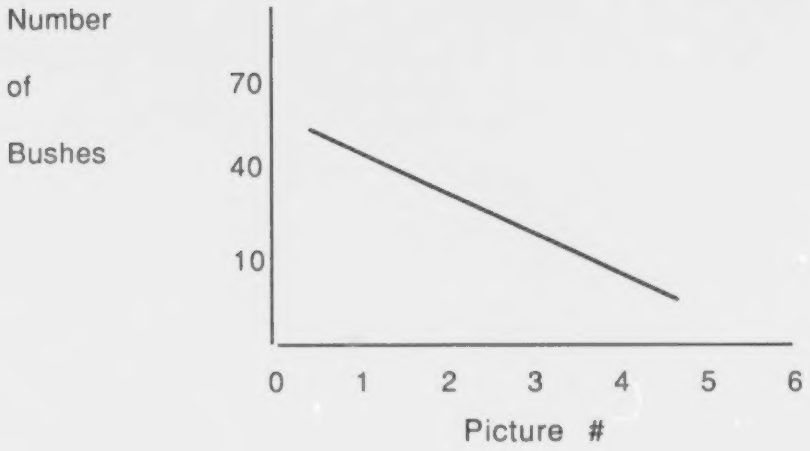
Review the lesson interactively involving the students to help them organize ideas related to succession and the growth of a forest. The teacher may also use resource speakers, slides, films, terrariums etc.

FINAL EVALUATION

Evaluation should be on-going and reflective in that the idea of growth of a forest and succession involves many science process skills. Students might be evaluated on participation and notebook work. Additional evaluation should consist of a short test for evaluating terms and problem questions involving inferential thinking skills concerning the module objectives.

Figure 2

Examples of Different Graph Formats to Use With Pictures



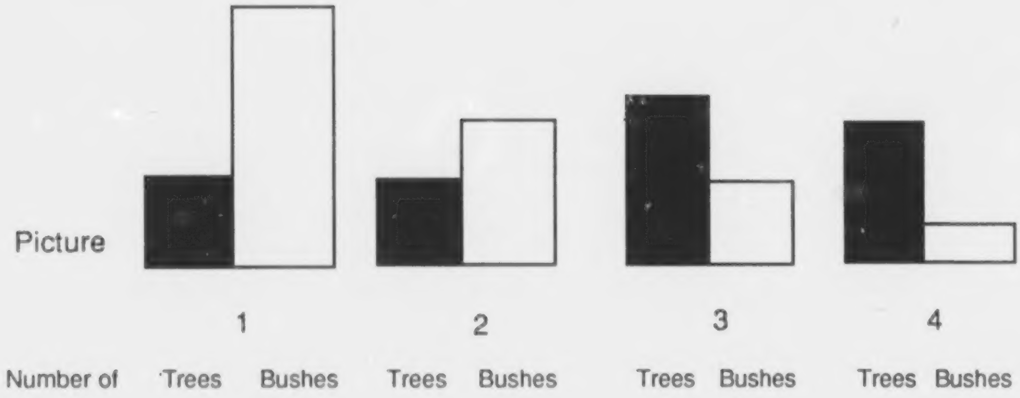


Figure 3

Successional Stages of a Bog Area

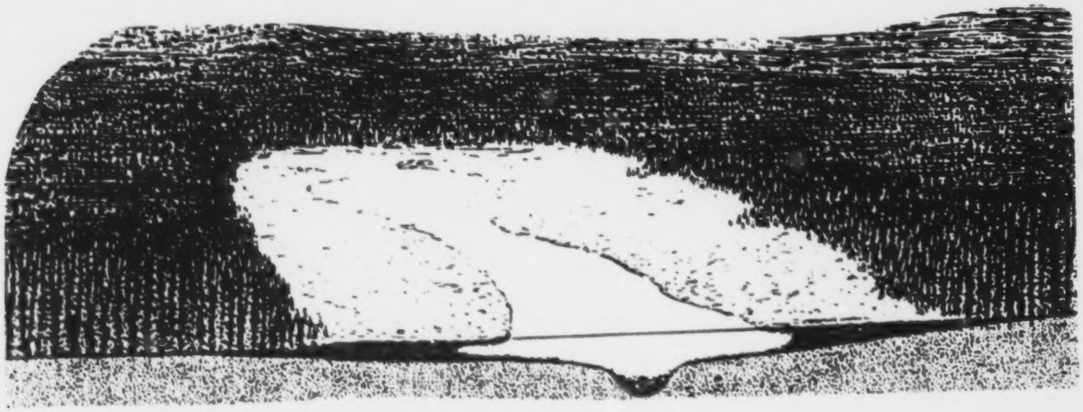
Flora found at Cranberry Glades:

surrounding area	bog area
spruce	round-leaved sundew
oak	large cranberry
hickory	small cranberry
	creeping snowberry
	skunk currant
	sphagnum moss
	sedges
	orchids

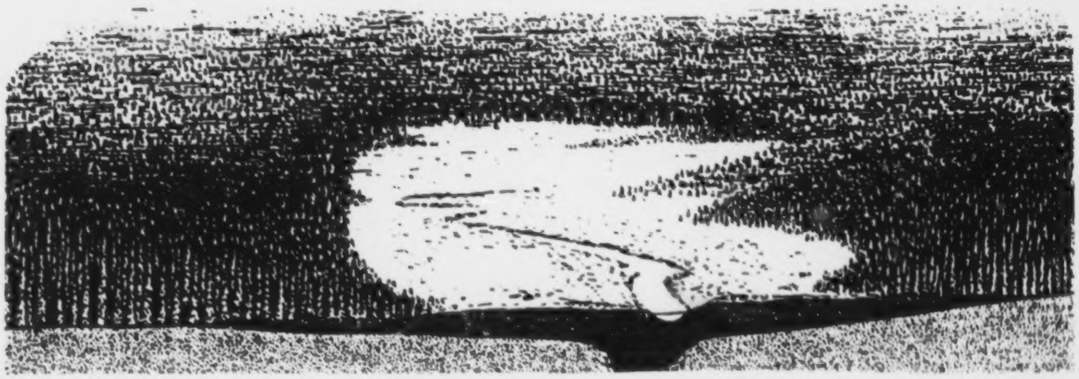
Figure 3 Continued

Successional Stages of a Bog Area

Cranberry Glades two thousand years ago



Cranberry Glades today



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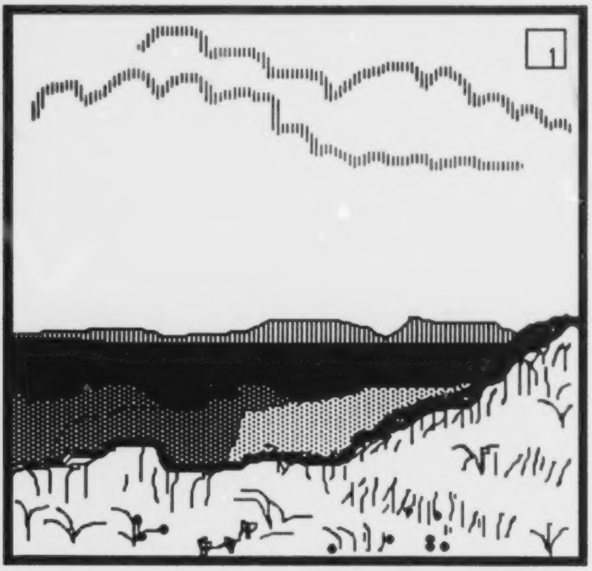
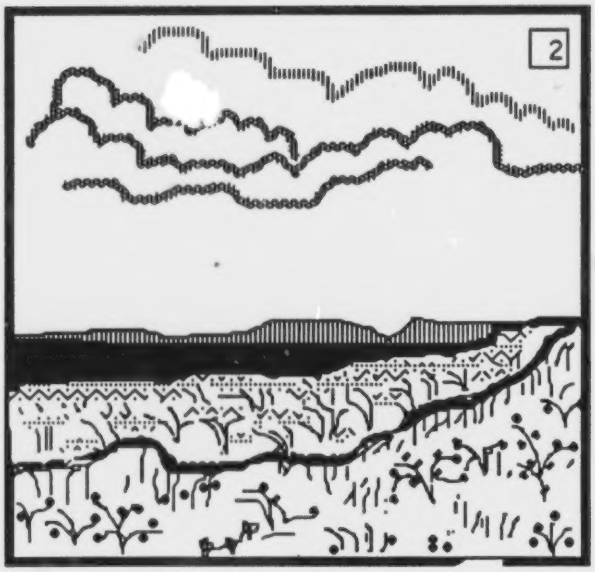
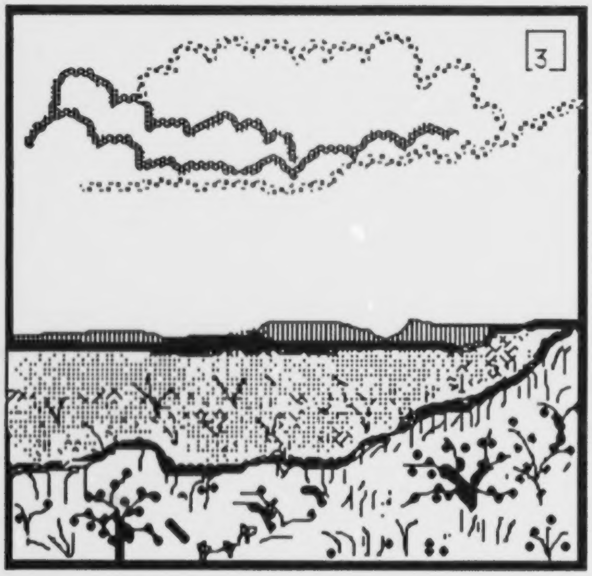
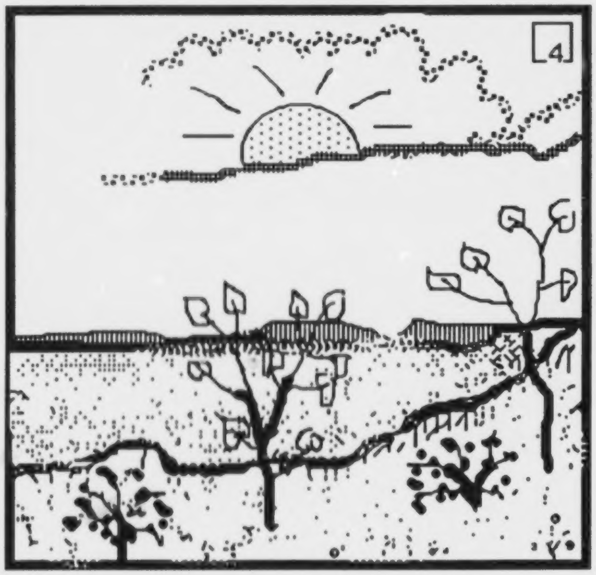
Student Handout #1

Forest Flip Charts









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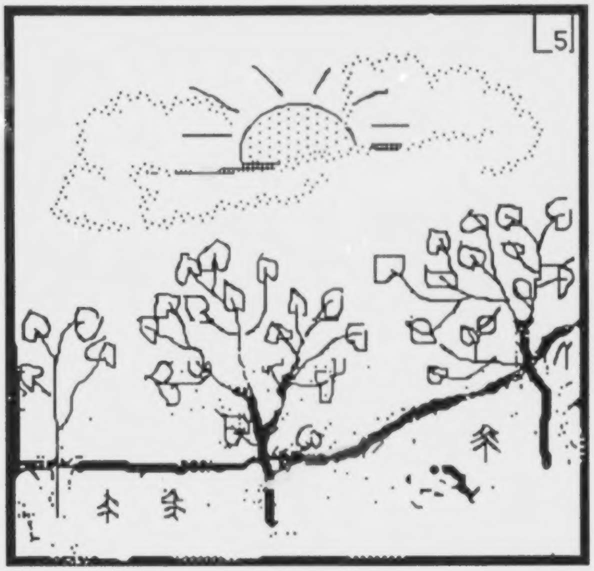
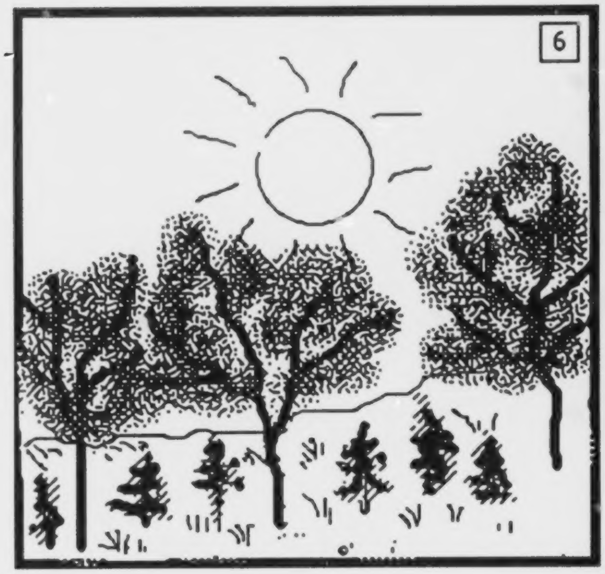
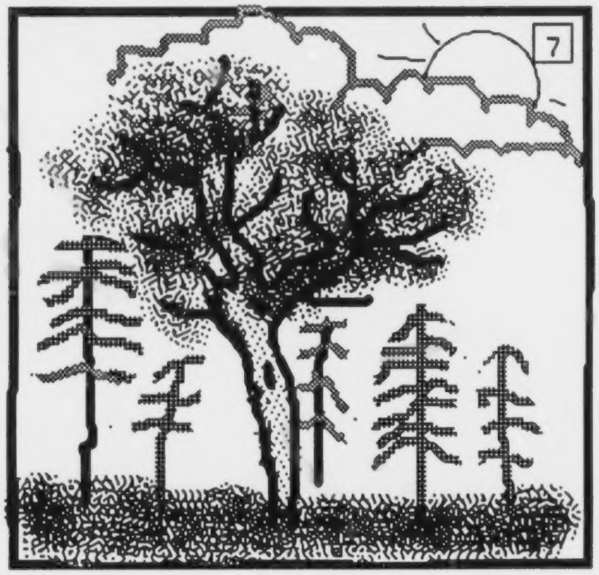
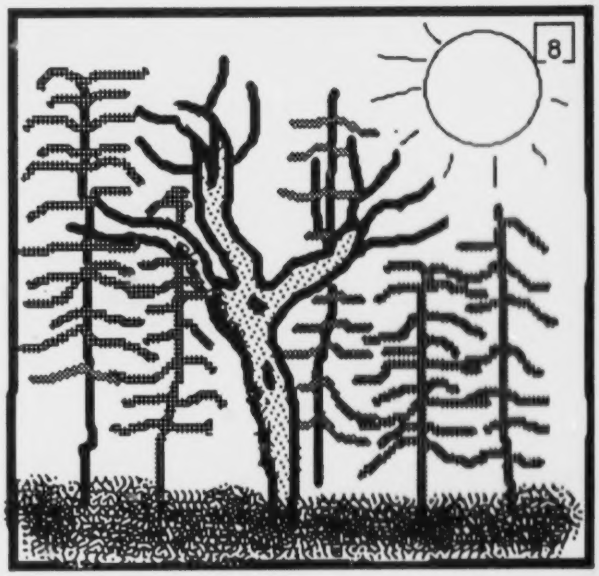
Student Handout #1 Continued

Forest Flip Charts









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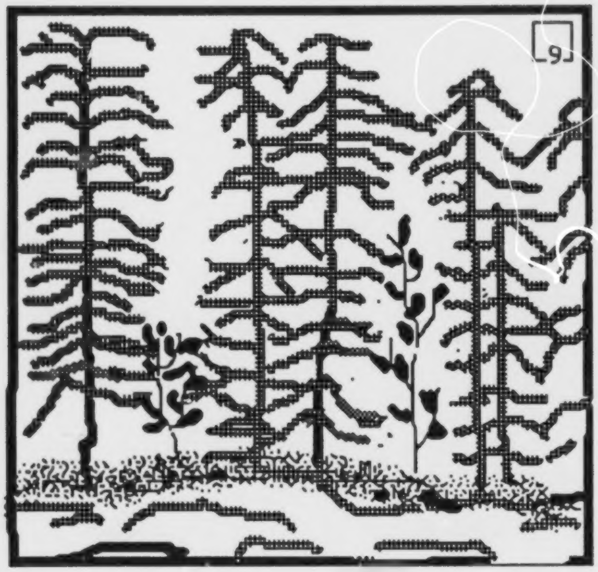
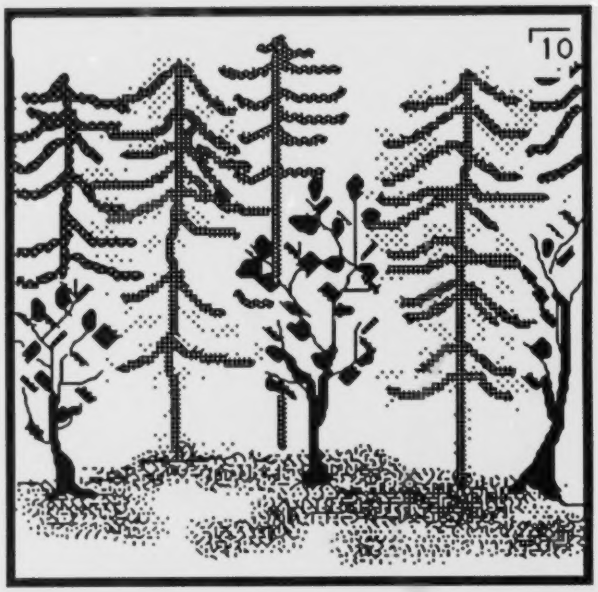
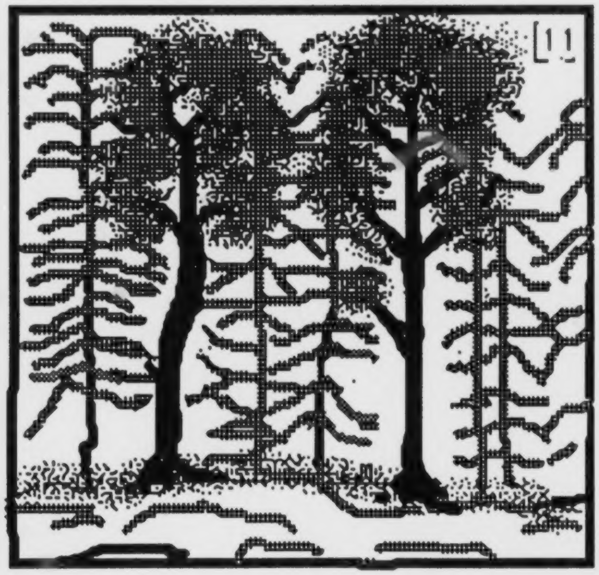
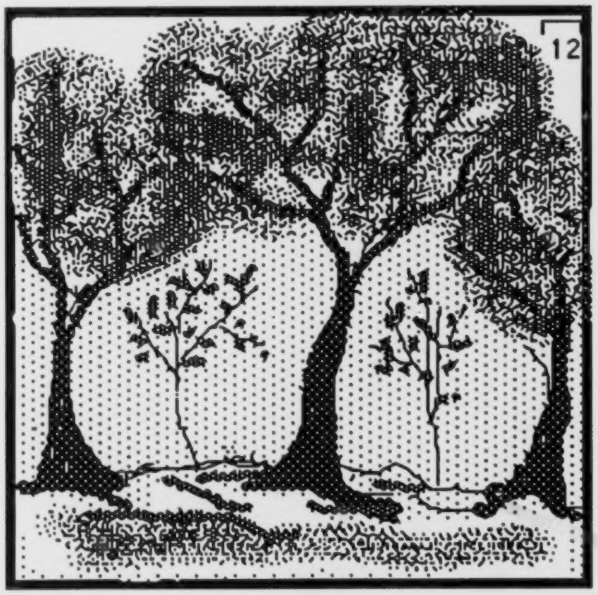
Student Handout #1 Continued

Forest Flip Charts









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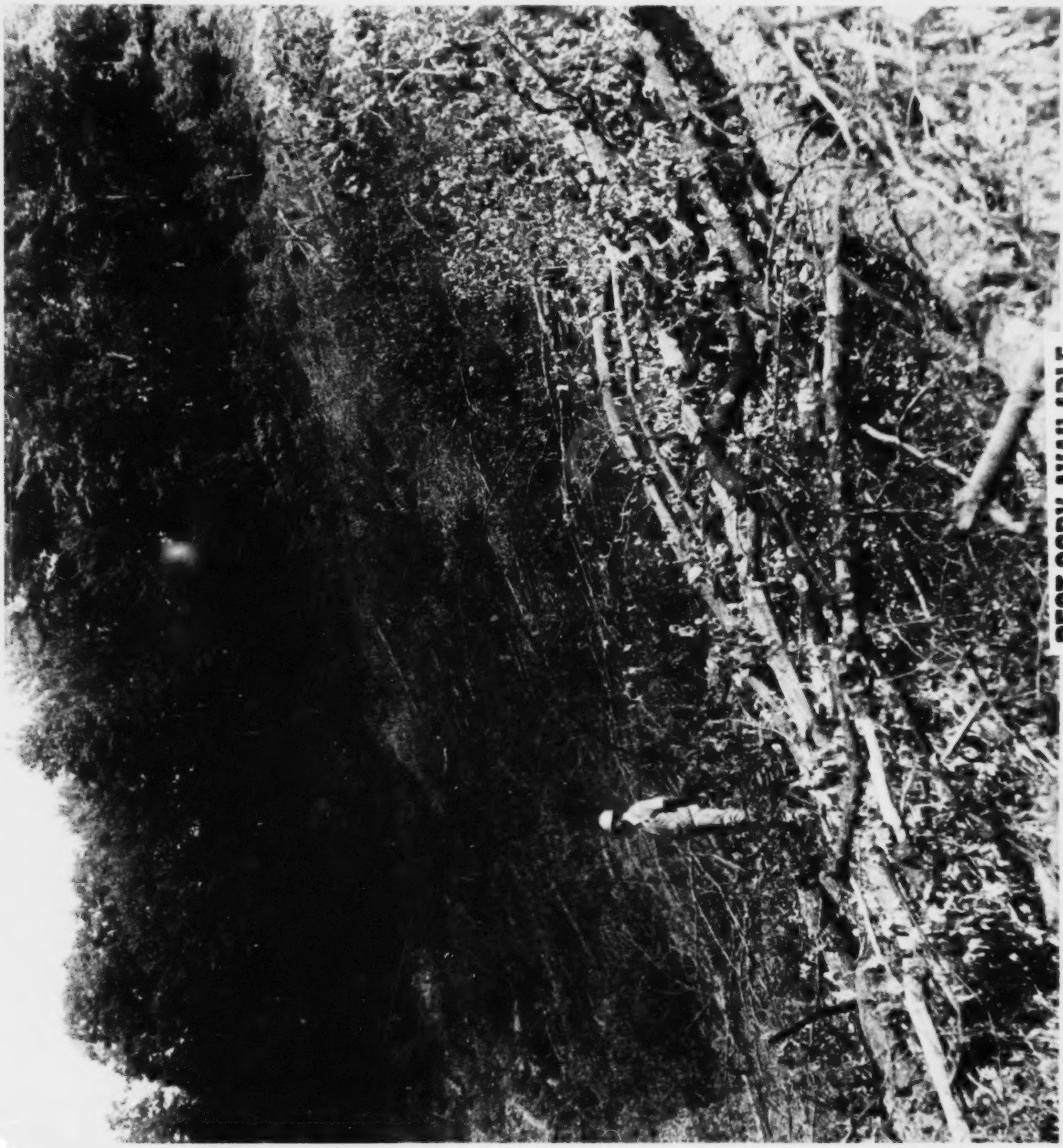
202

Student Handout #2

Six photographs taken of the same location many years apart - Photo 1, a clearcut forest area.



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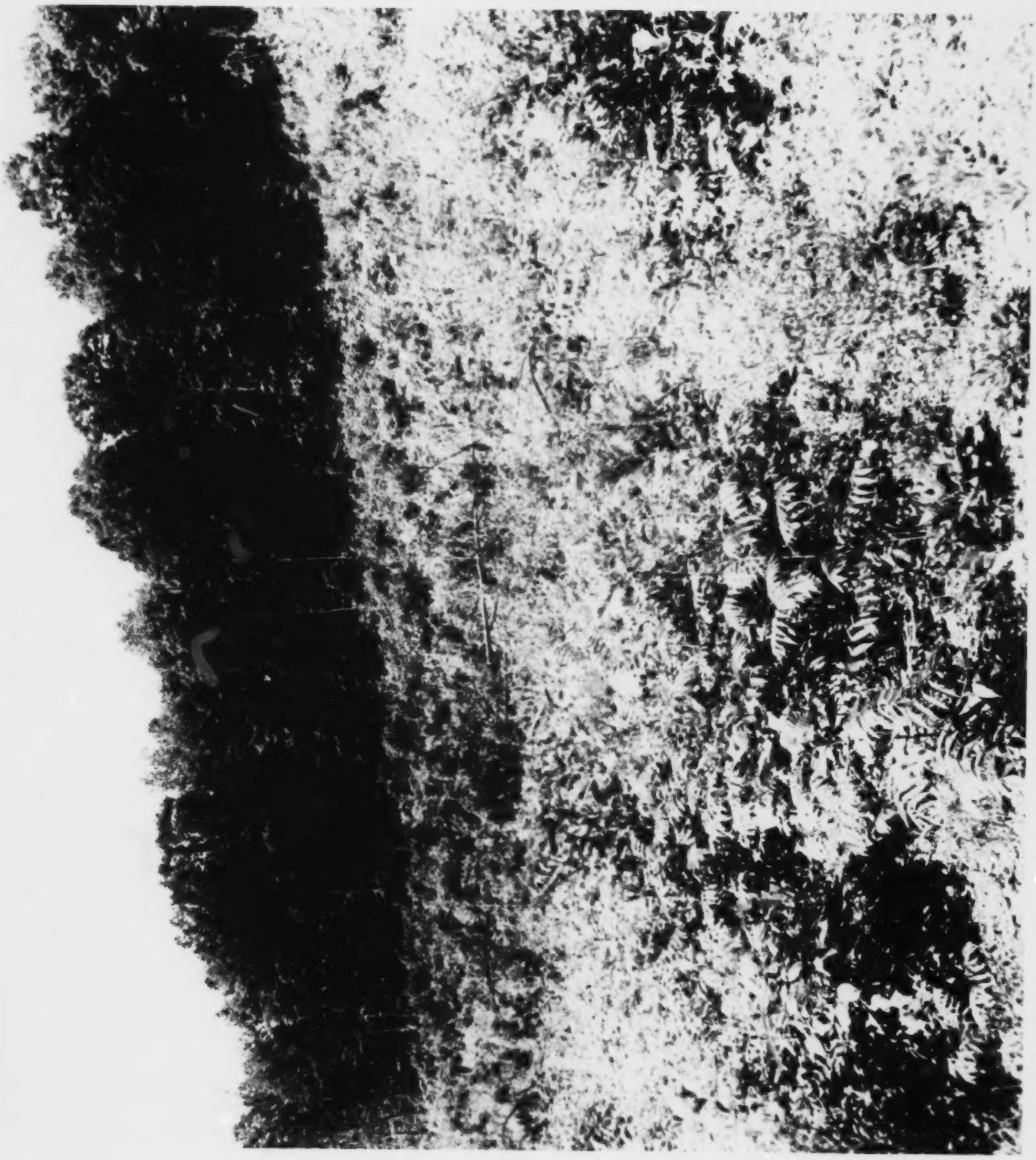
201

Student Handout #2 Continued

Six photographs taken of the same location many years apart - Photo 2, same area 4 years later.



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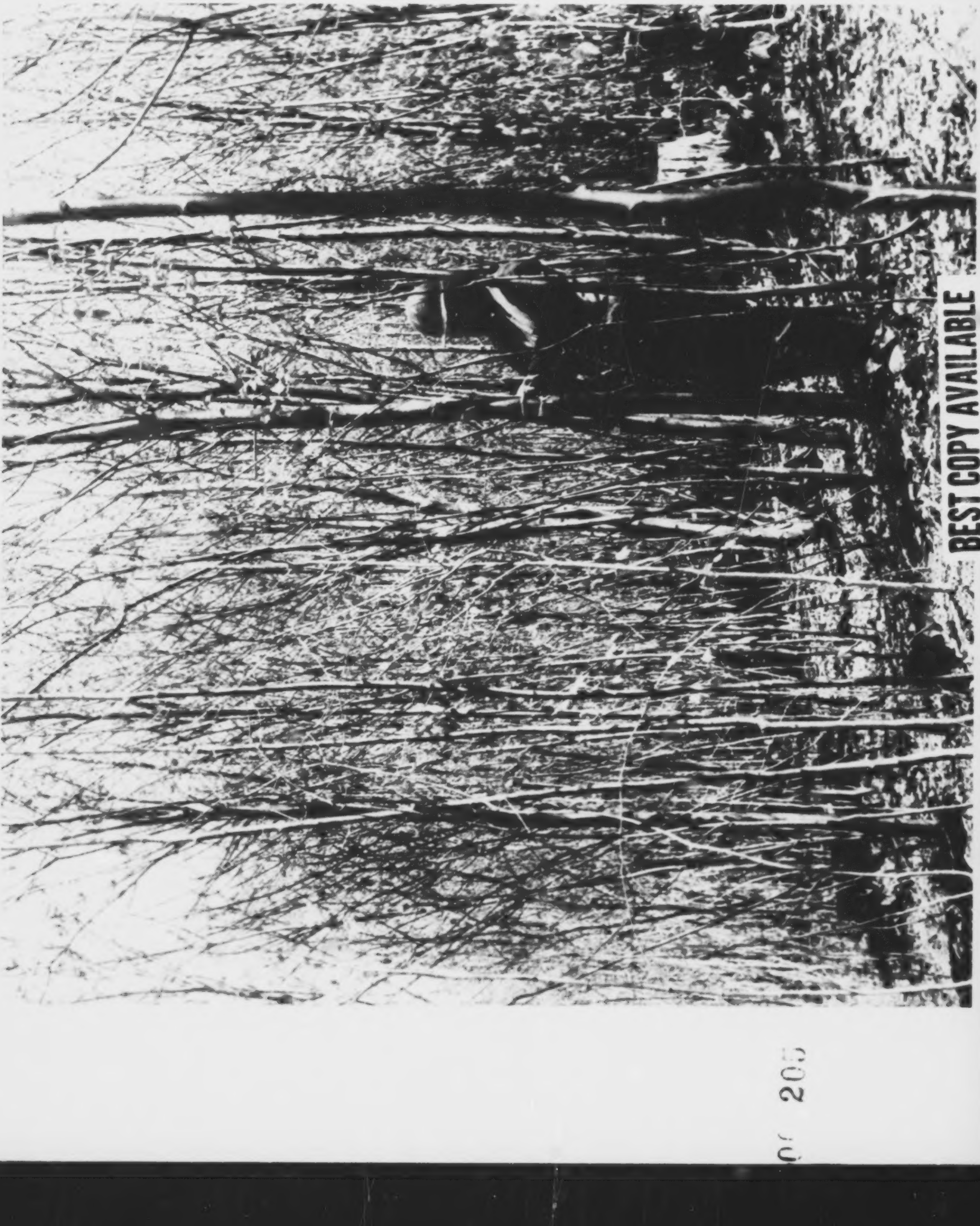
Student Handout #2 Continued

Six photographs taken of the same location many years apart - Photo 3, same area 10 years after cutting.



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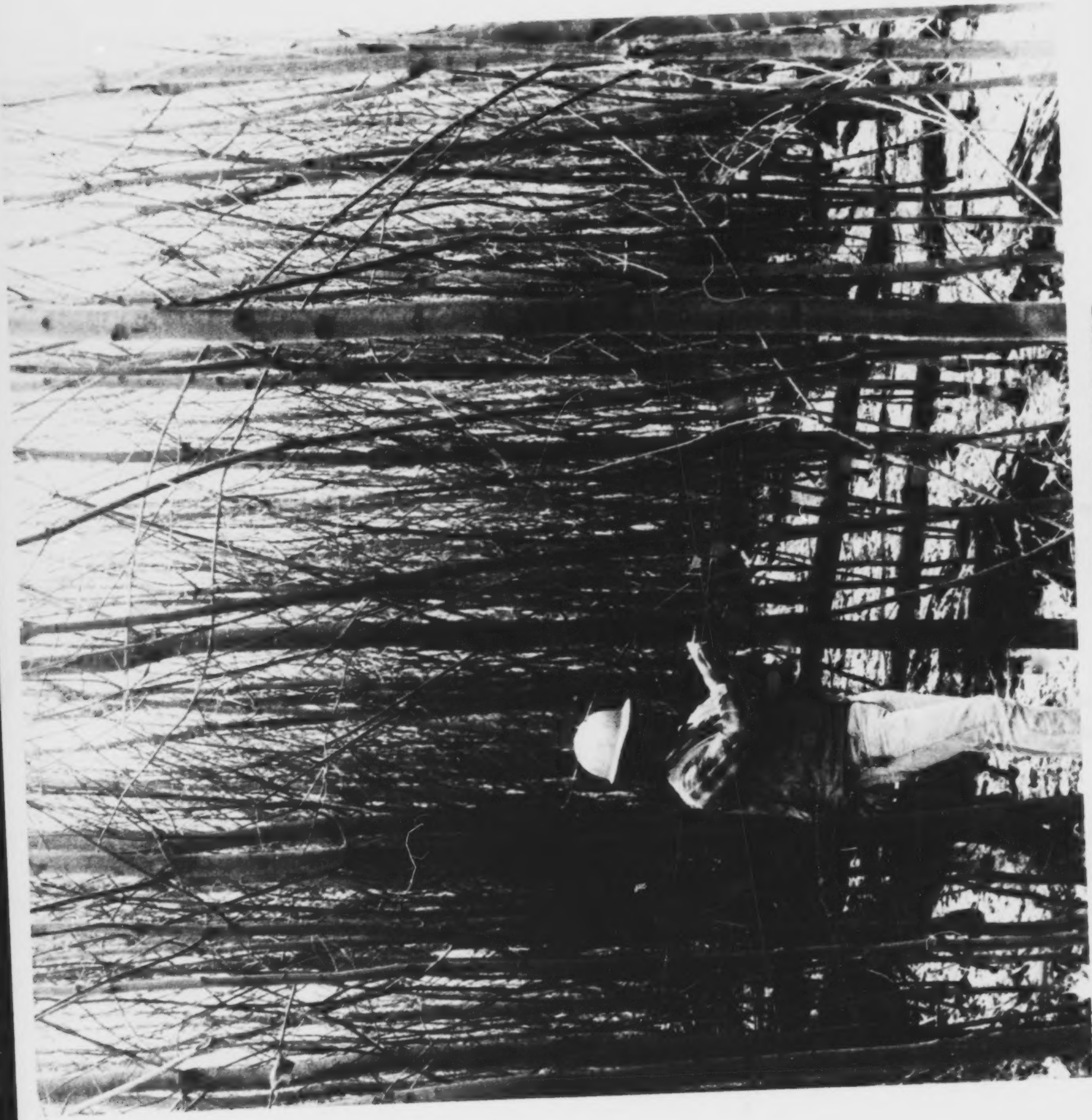
Student Handout #2 Continued

Six photographs taken of the same location many years apart - Photo 4, same area 18 years after cutting.



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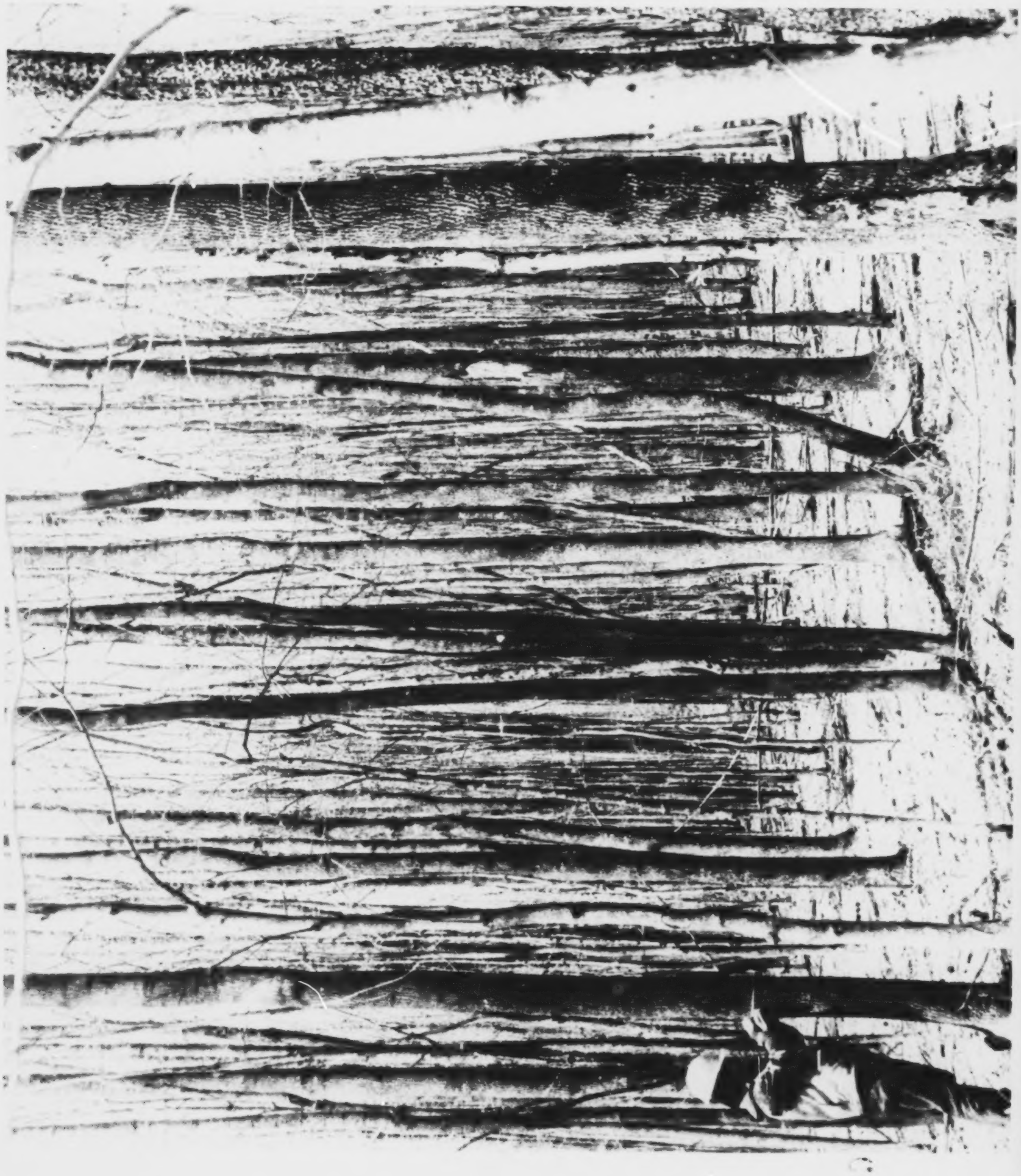
Student Handout #2 Continued

Six photographs taken of the same location many years apart - Photo 5, same area 35 years after cutting.



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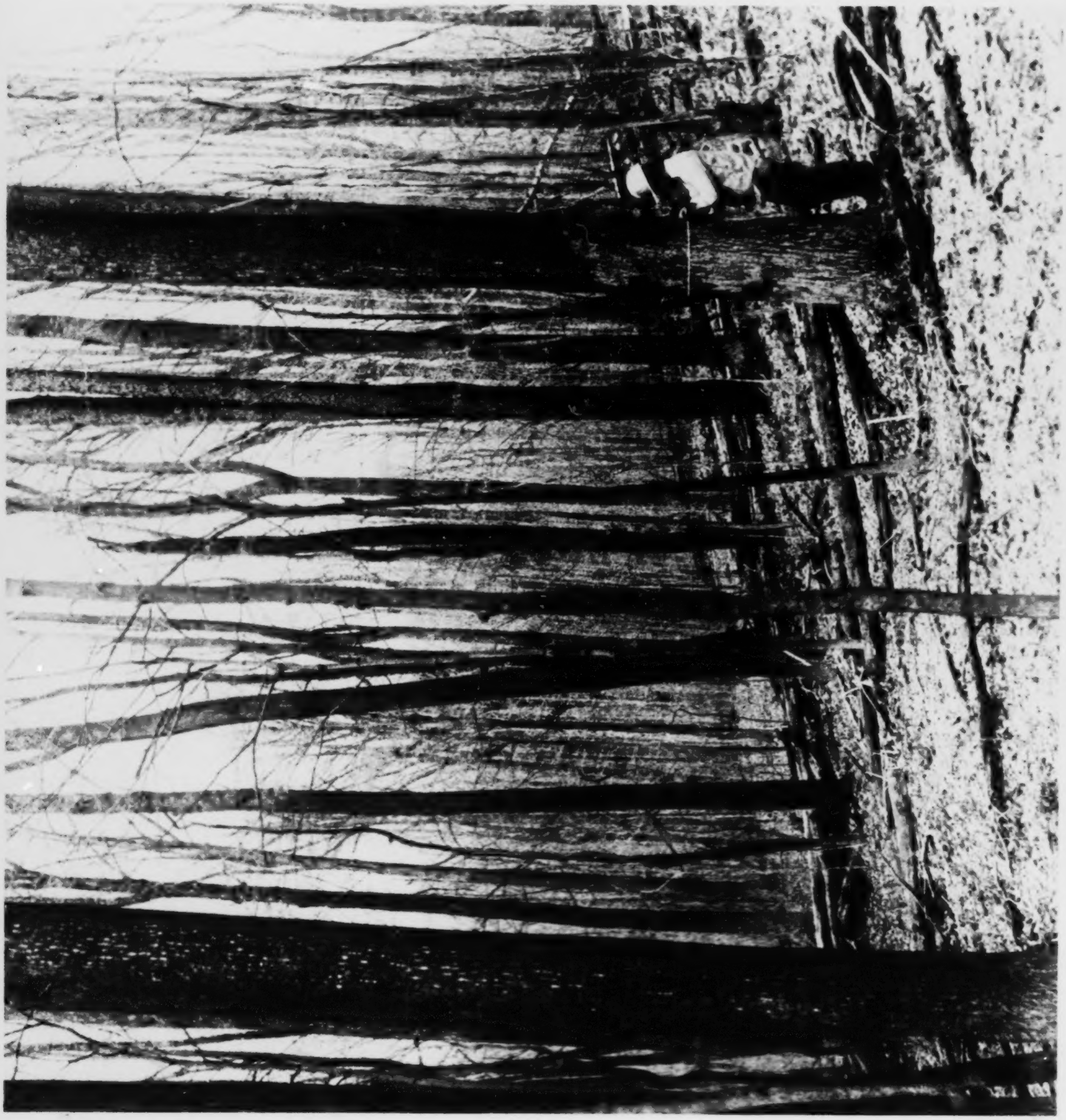
Student Handout #2 Continued

Six photographs taken of the same location many years apart - Photo 6, same area 70 years after cutting.



Student Handout #2 Continued (page 2)

Recording Sheets

Picture 1

	rocks/soil	weeds	bushes	trees
Present (?) yes/no	______	______	______	______
Identify or Describe				

Picture 2

	rocks/soil	weeds	bushes	trees
Present (?) yes/no	______	______	______	______
Identify or Describe				

Picture 3

	rocks/soil	weeds	bushes	trees
Present (?) yes/no	______	______	______	______
Identify or Describe				

Student Handout #2 Continued (page 3)

	rocks/soil	weeds	bushes	trees
Picture 4				
Present (?) yes/no	_____	_____	_____	_____
Identify or Describe				

	rocks/soil	weeds	bushes	trees
Picture 5				
Present (?) yes/no	_____	_____	_____	_____
Identify or Describe				

	rocks/soil	weeds	bushes	trees
Picture 6				
Present (?) yes/no	_____	_____	_____	_____
Identify or Describe				

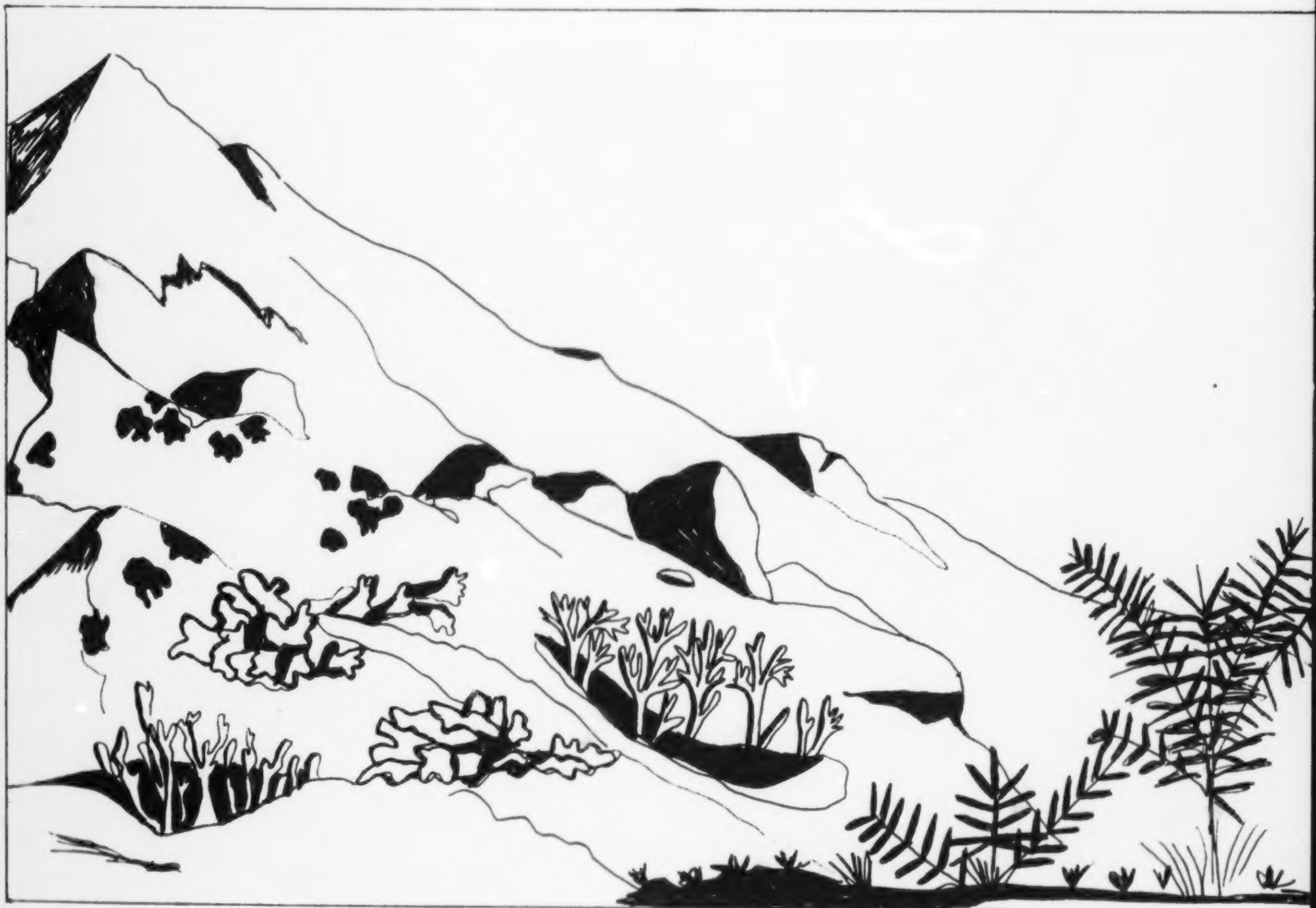
---

* Photos provided by the United States Department of Agriculture, U.S. Forest Service, Northeastern Forest Experiment Station, Parsons, WV, 26287.

STUDENT HANDOUT 3

Primary Succession on Rock Surface

The conversion of bare rock to forest takes thousands of years. Succession begins when lichens dissolve minerals from rock surfaces. When conditions are favorable mosses grow and accumulate organic and mineral matter. A layer of soil can accumulate to provide habitats for ferns and, later, for grasses and herbs. Succession can continue to the point where shrubs and tress can grow.



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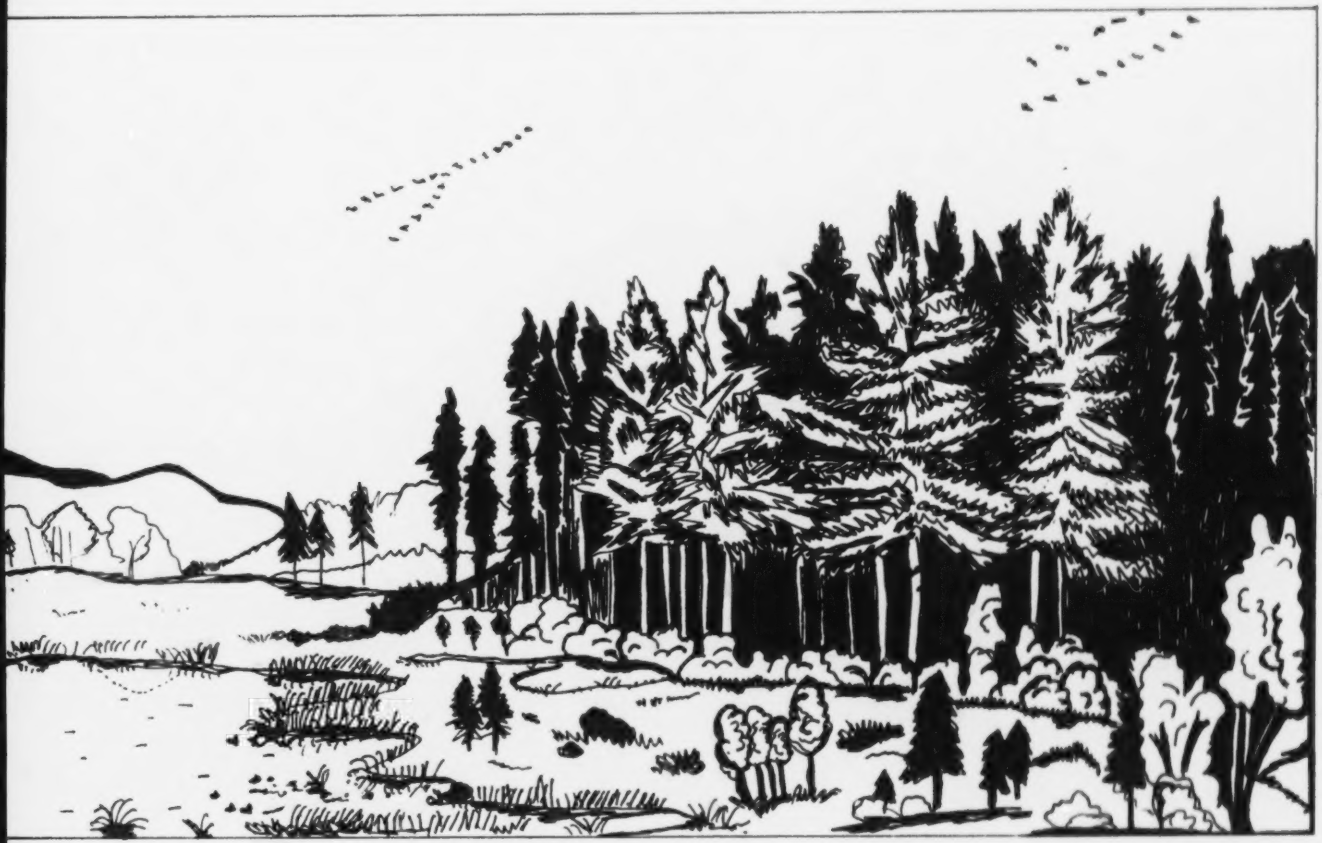
* These examples were adapted from Agriculture Information Bulletin #426, United States Department of Agriculture, U.S. Forest Service.

STUDENT HANDOUT 3 Continued

Northern Lake Primary Succession

A northern lake has a short lifetime, geologically speaking. Through a successional series of events lakes (on left) change into a sphagnum bog (center). The bog may become a swampy forest of red maple, spruce, fir, and larch. Later a forest of northern hardwood trees may eventually develop (right).



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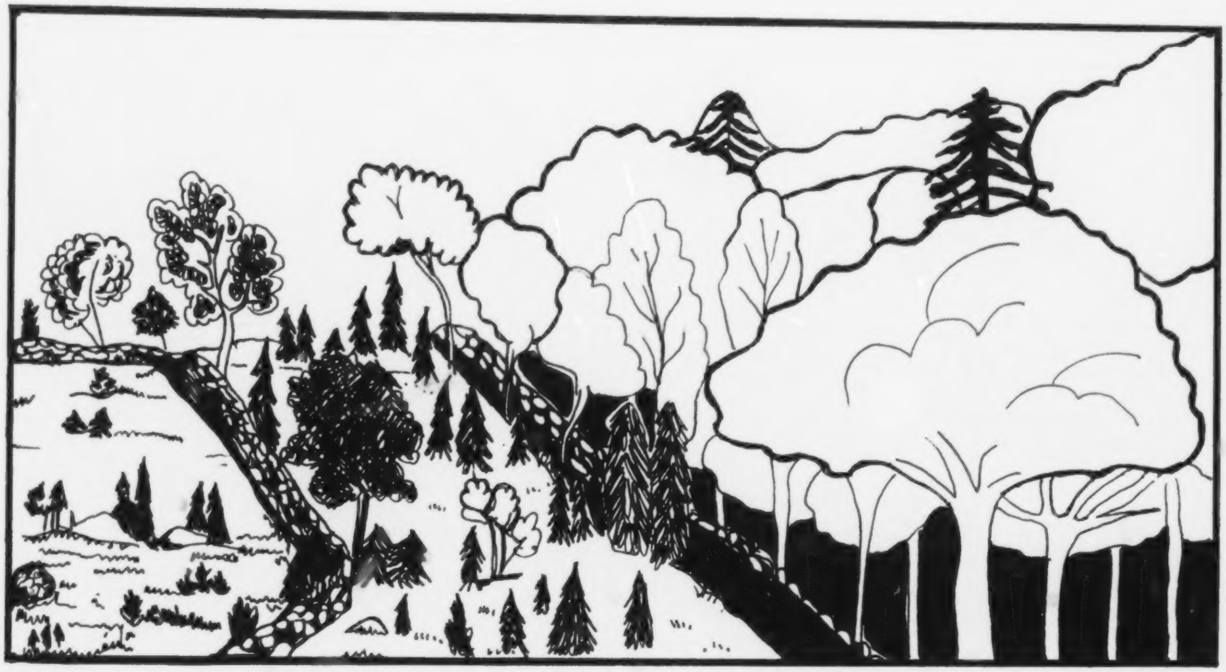
STUDENT HANDOUT 3 Continued

Southeastern Secondary Succession

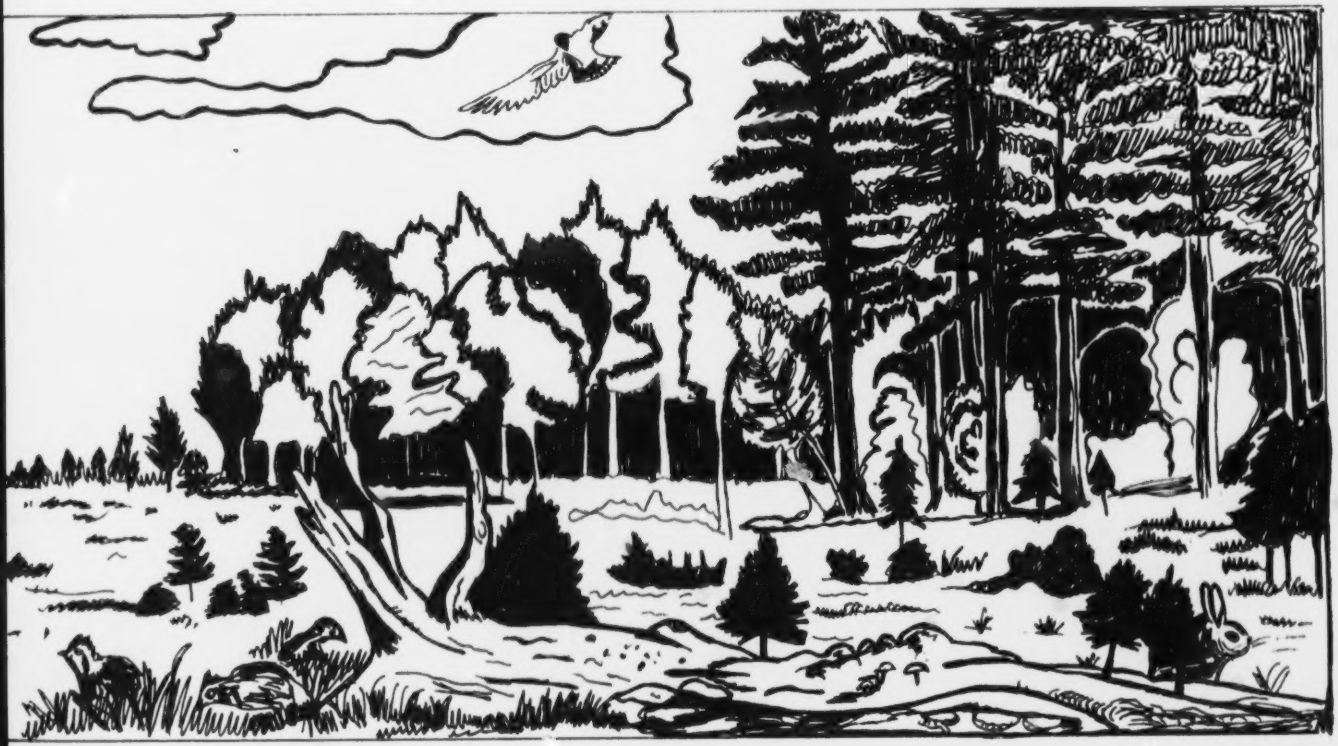
Abandoned farmlands are invaded by pioneer grasses and shrubs (center) to loblolly pine (right). Tree species such as pines, oaks and hickories, which may make their appearance early, usually become dominant later (background). Successional development from a plowed field to a relatively stable forest requires about 150 to 200 years.



STUDENT HANDOUT 3 Continued

Northeastern Secondary Succession

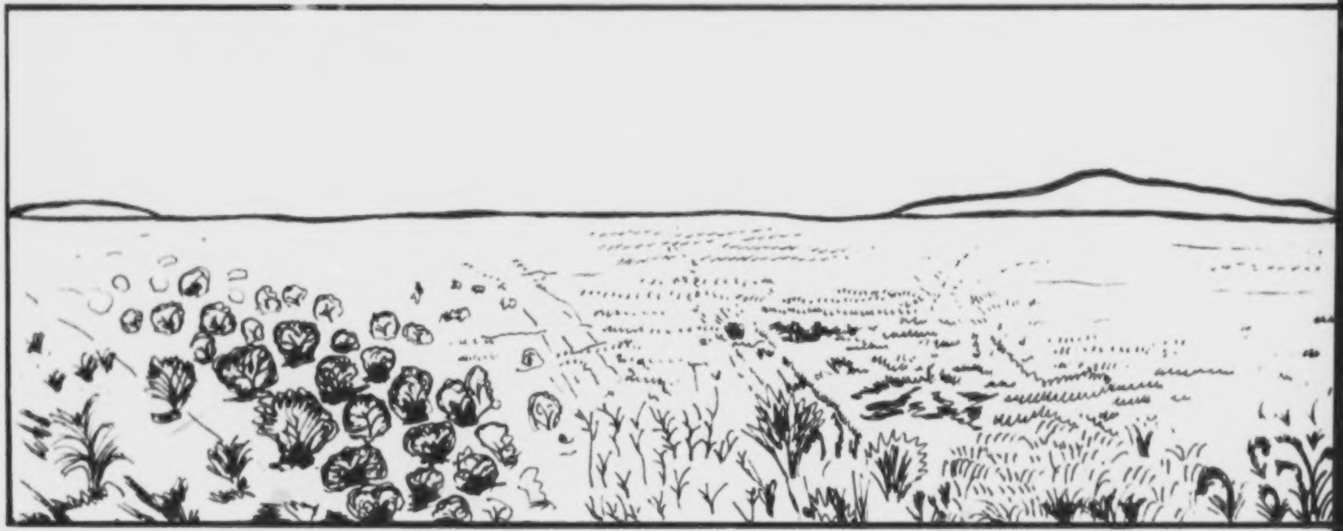
Field succession in the New England typically passes from communities of grasses and herbs to shrubs of red cedar black cherry. Finally succession leads to a relatively stable forest of oaks, sugar maple, yellow birch and American beech. This process requires 200 years when conditions are favorable.



STUDENT HANDOUT 3 Continued

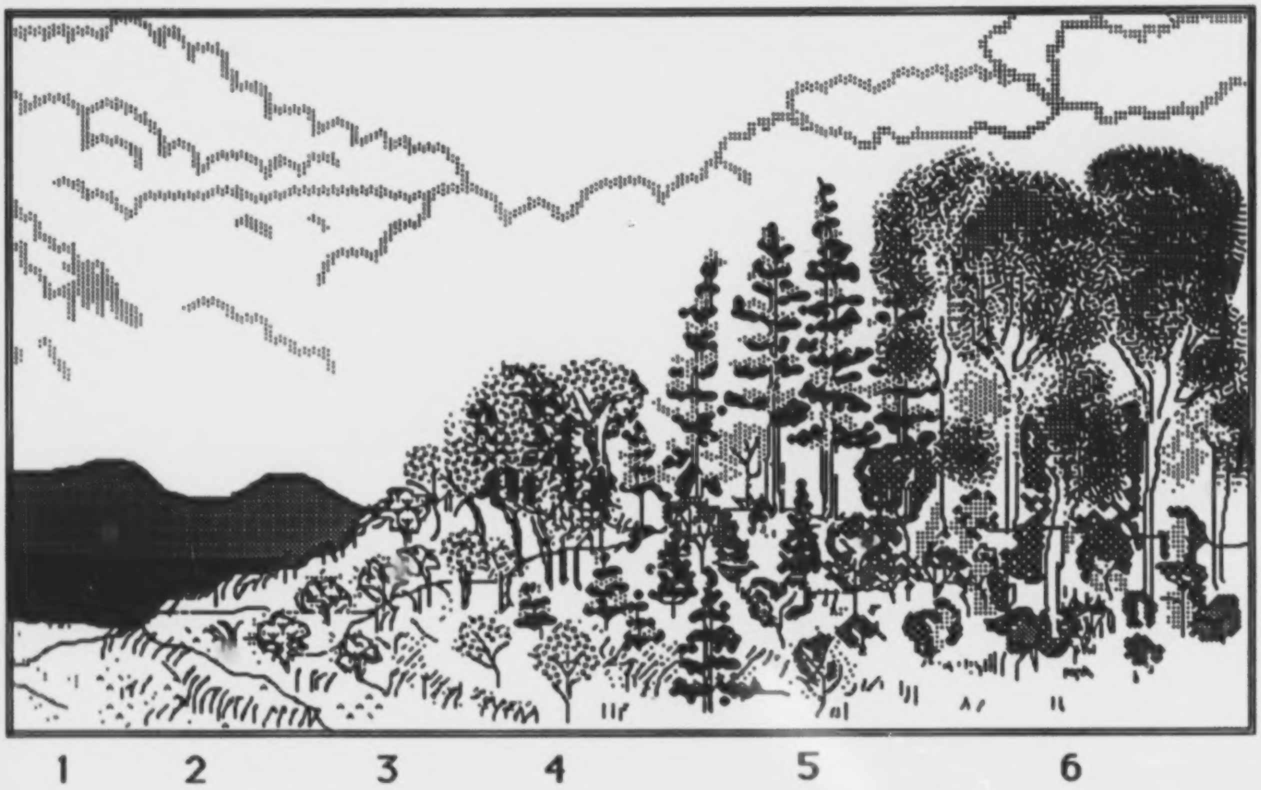
Primary Succession in Grassland

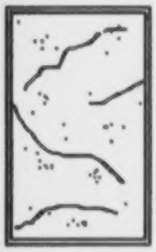
Succession can also occur in non-forest areas, including lakes, oceans, and grasslands. Grassland development can takes place on bare land in many regions in the Eastern United States where the conditions are appropriate. For the bare ground (left) to pass through communities of scattered annual weeds (left-center), short-lived grasses (center), and early perennial grasses (center-right) to the original dense, stable grass community (right) requires 20 to 40 years.

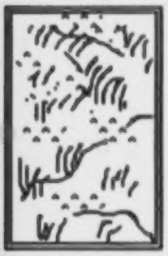


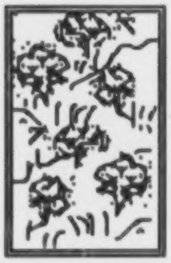
STUDENT HANDOUT 4

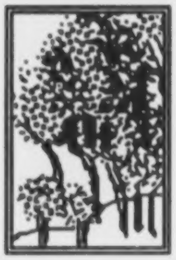
Shoreline Vegetational Communities

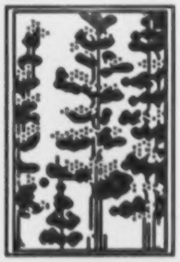


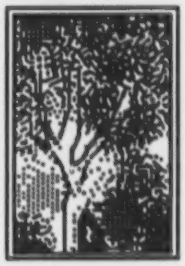

Area with bare sand and some grasses

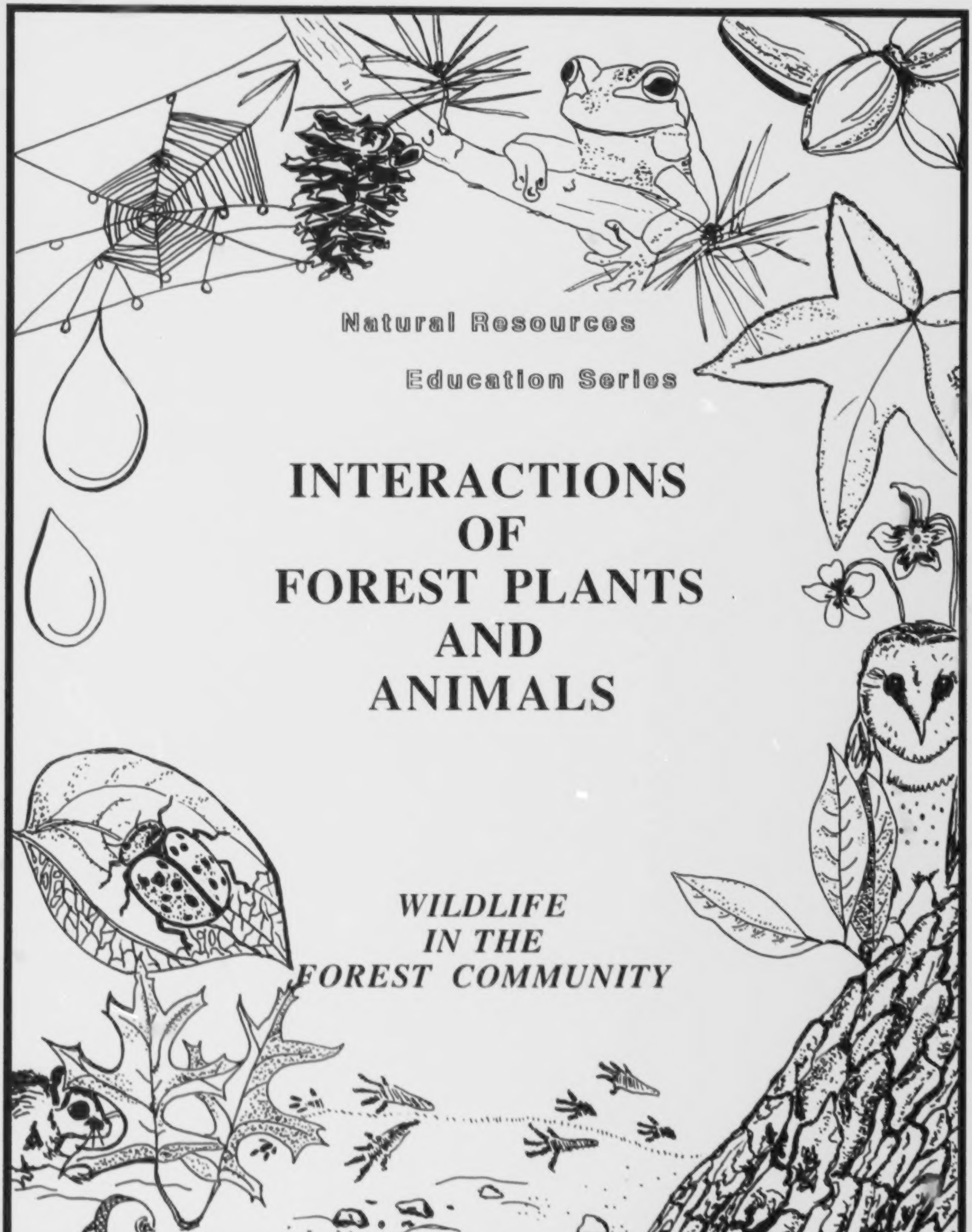

Area dominated by mosses and grasses


Area dominated by grasses and shrubs


Forest dominated by cottonwood trees


Forest dominated by pine trees


Forest dominated by hardwood trees



Natural Resources

Education Series

INTERACTIONS OF FOREST PLANTS AND ANIMALS

WILDLIFE IN THE FOREST COMMUNITY

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The writing, development and, production of the *NATURAL RESOURCES EDUCATION SERIES* is a joint project with collaboration of project directors Dennis W. Sunal, The University of Alabama, and Mary E. Haas, West Virginia University, and the U.S. Forest Service. Partial funding was provided by the U.S.D.A. Forest Service. The initial author and series editor was Dennis W. Sunal. Revision of individual modules was carried out with the help of Mary E. Haas, and Cynthia S. Sunal. Assistance in creating appropriate activities, proof reading, and creating art work by computer for the many editions was provided by Jon Berninzoni, Elwin Dickerson, Tracy Johnson, Jane McGinnis, and Sukhwindar Singh. Final editing assistance on the text and artwork was performed by Audrey Rule. William Kline, Jr. assisted in training the original trial teachers. Content reviewers were specialists in the various module topics at the U.S. Forest Service including Monongahela National Forest staff members, Theresa Anne, Randolph Harrison, Linton Wright, and Harry Mohoney, and Northeastern Forest Experiment Station, Timber and Watershed Laboratory staff Pamela Edwards, David Helvey, James Kochendorfer, and Clay Smith. Teachers in the Randolph County, West Virginia Schools who first taught the modules and made recommendations for revisions were: Sandra Arbogast, Sara Basil, Ann Deloach, Karen Hall, Richard Leitner, Elizabeth McDonald, Linda Moore, Sharon Moss, Pam Mullennex, Jeff Ranhart, Theresa Skidmore, Rachel Snavely, Charles Swecker, Nancy Taylor, Angela Vance and Rebecca Wallace.

The *NATURAL RESOURCES EDUCATION SERIES* is designed to supplement textbooks with active learning lessons for students in the primary and middle childhood grades (K-8). The series consists of Understanding Our natural Resources Teacher's Guide and 12 Modules including Appreciation of Natural Beauty, Soils and Plant Growth, The Water Cycle, Natural History of a Tree, Recipe for Tree Growth, Tree Growth and Environment, Forest Processes, Managing Our Forest Resources, Growth of a Forest, Interactions of Forest Plants and Animals, Natural Watersheds, and Managing Our Natural Resources.

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INTERACTIONS OF FOREST PLANTS AND ANIMALS

INTERACTIONS OF FOREST PLANTS AND ANIMALS

WILDLIFE IN THE FOREST COMMUNITY

BACKGROUND INFORMATION FOR TEACHERS

This module will encourage students to think about and be involved with interactions occurring in forests between the communities of plants and animals and their environment. The module would fit chapters in an existing science text or unit relating to where plants and animals live, uses and misuses of plants and animals, food chains and food webs, how living things survive, ecosystems, predator/prey relationships, succession, and climate's influence on life. The activities within this module ideally require several days, but are flexible enough to be shortened or extended to fit the teacher's schedule. The module requires some advance preparation. The teacher is advised to read over the units carefully and plan accordingly.

The forest is one of the most widespread of earth's vegetation types. Belts of forested areas exist around the world; examples include tundra, coniferous forest (e.g. pine, spruce), deciduous forest, and tropical forest. All forests have a large and diverse amount of living matter. This life comprises several layers, or strata, of vegetation which influence environmental conditions within the forest. This environment includes varying levels of light, moisture, temperature, wind, and carbon dioxide.

The forests of the eastern United States are temperate, highly developed, uneven aged, and mostly deciduous. Such temperate forests usually consist of four strata. Dominant trees comprise the upper layer, or upper canopy. Beneath the upper canopy is the lower tree canopy or understory. Below this layer is the shrub layer. The ground or field layer, the lowest layer, consists of herbs, ferns, and mosses.

Fire, heavy cutting, and other large disturbances are factors that produce even aged stands, a group of similar aged trees growing in a continuous area. These stands frequently have poorly developed strata beneath the canopy because of dense shade. The low tree and shrub strata are usually thin and the ground layer often is poorly developed, except in small, open areas.

The levels of a stand contribute to the diversity of animal life and different growth forms of plants. Specific plant and animal species, especially birds and insects, primarily confine their activities to one stratum (see Figure 1). However, the greatest concentration and diversity of life is found on, and just below, the ground layer. Many animals, especially soil invertebrates like worms and insect larvae, are found below ground. Some vertebrates such as mice, shrews, rabbits, ground squirrels, and foxes burrow into the soil for shelter or food, but spend much time on the ground layer. Larger mammals, such as deer, live on the ground layer feeding on herbs, shrubs, and low trees.

Upper Tree Canopy
Blackburnian Warbler
Scarlet Tanager
Tit Mouse
Great Horned Owl
Squirrel
Redbreasted Nuthatch

Lower Tree Canopy
Red Eyed Vireo
Opossum
Wood Peewee
Squirrel

Shrub Layer
Millipede
Spider
Moth
Hooded Warblers

Ground Layer
Ruffed Grouse
Hooded Warblers
Shrew
Wild Turkey
Deer
Fox
Rabbit
Muskrat
Raccoon
Skunk
Mouse
Millipede
Squirrel
Spider
Opossum

Figure 1
Some Occupants of Forest Strata

OBJECTIVES: Choose those appropriate for your students. Select those objectives appropriate for your students.

-Identify naturally occurring organisms in tree stand, shrub or grass areas.

-Observe, record, and illustrate interactions of trees and animals.

-Recognize the relationships between animals and plants.

-Study different habitats that a single tree can provide for wildlife.

-Collect/identify animals present in different forest strata (layers) and infer interactions.

-Identify relationships (and interdependence) of plants and animals in forest community interactions.

-Predict constructive/destructive effects forest animals have on the forest.

EXPLORATION PHASE

TO THE TEACHER:

The initial phase of exploration involves interactive activities using observation and other science process skills to help students, on their own, discover basic concepts and relationships in forest community interactions. The teacher should use this time to organize groups, observe interactions, and permit students to investigate possibilities themselves. Students should be asking questions, gathering first hand information, and making connections to their previous experiences in and out of school. Ideally the student should be confronted with a problem or event which cannot be explained by past knowledge.

EARLY CHILDHOOD ACTIVITIES

Materials: for each group
- 1 oaktag, cardboard, or poster board
- 2-3 sheets of construction paper in shades of green and brown
- 1 sheet green tissue paper
- 1 pair of scissors
- 1 bottle of glue to share
- 5-20 plastic insects and forest animals, or clay to make them, or paper animal cut-outs from magazines

Involve the students in the following activities:

1. Prepare a display of a forest by using oaktag and construction paper as shown in figure 2.

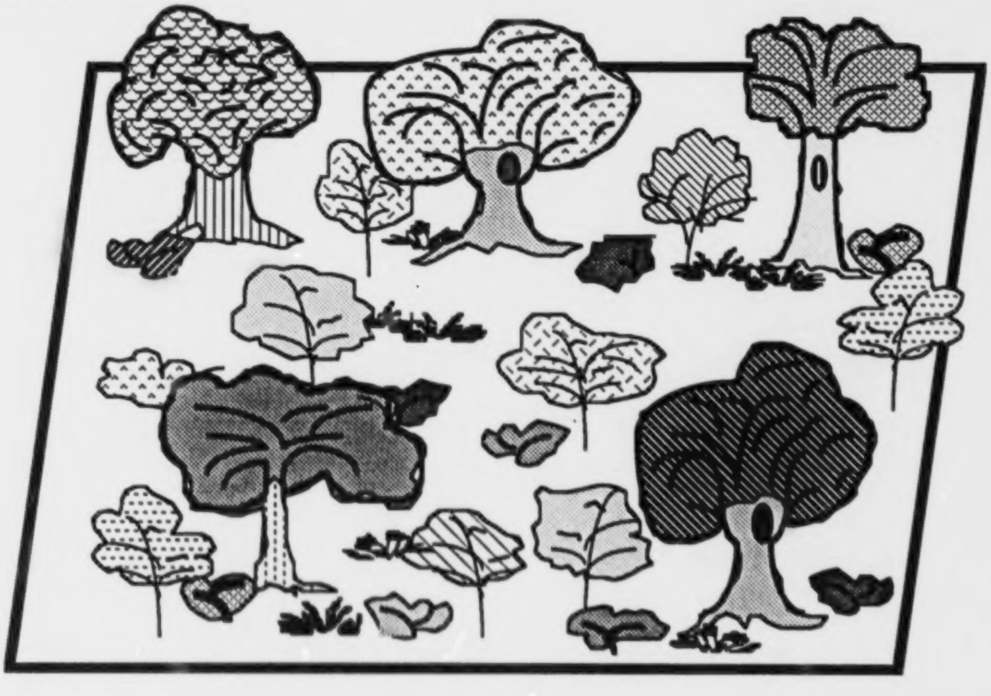


Figure 2
Forest on a Poster Board

Glue tree tops of various shapes and sizes on to oaktag tree trunks then glue trees to poster board or oaktag ground space as shown in figure 3.

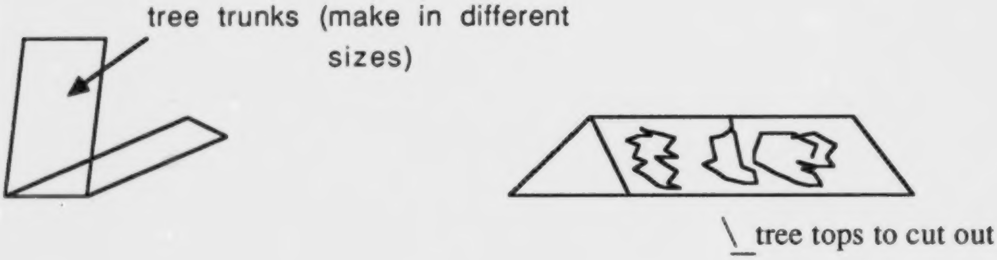


Figure 3
Tree Construction

Make vegetation for each layer (stratum). Have tall dominant trees with wide upper canopies; small, thinner understory trees; shrubs; and ground covers (grasses, weeds, mosses, etc.) Bushes and shrubs can be made of crumpled green tissue paper. Ground covers can be made of green construction paper fringe. You might even want to add small rocks to represent boulders.

2. Give students small plastic, rubber, or clay (could be made by the students) models of animals and insects. Cut-paper insects and animals or pictures of animals and insects common to the forest also can be used.

3. Tell the students to place the animals and insects in the forest model where they think they would like them to be. Have enough so that the forest will look crowded.

4. Use the following questions to discuss the scene.

   * What is happening in our forest?
   * What do forest animals and insects eat?

   * Is there enough food for them to eat?
   * How does forest animals benefit from forest plants (interact)? Birds eat plant seeds.

   * How does forest plants benefit from forest animals (interact)? Plant seeds are scattered by birds.
   * How do forest animals and plants depend on each other (interact)? Birds and plants benefit from each others actions.

MIDDLE CHILDHOOD ACTIVITIES

Materials: for each group

- Student Handouts 2, 3
- Table 2
- trowel for class or for each group
- magnifying glass for each student, if possible
- Life History Notes in Student Handout 1 at the end of this module
- writing materials
- large jar with screw-type lid.

For optional activities: for the class

- *6 - 10 pieces of heavy cardboard or wood (about 30 centimeters square)*
- *3 - 6 large coffee or juice cans*
- *5 meters (15 feet) of string and 12 or more stakes or 3 - 6 clothes hangers*
- *some food scraps*
- *white piece of plastic or white sheet*
- *2 or more collecting jars or boxes*
- *1 spoon*
- *1 roll transparent tape*

Involve the students in the following activities:

TO THE TEACHER:

The activities below involve developing a class inventory of natural plants and animals on the school grounds. Choose those appropriate to you objectives. Divide the class into small groups of two to four students. You may wish to assign roles for accomplishing the tasks, such as group leader responsible for equipment and task completion, recorded, and collector. Assign the groups to a specific observing task. Ask the students to complete an inventory describing the natural wildlife found in an area near the school. In addition, you will ask them to determine whether any of these animals depend on other living things. Choose one or more areas around the school which have potential for observing a larger number of types of wildlife. A stand of trees or shrubs, a fence line or an uncut lawn area in or near the school grounds will suffice. If areas around the school contain only insects and a few birds, expand the questions to all types of living things, plant and animal. Be wary of poison ivy in fence rows and fields.

1. Take a walk around school grounds, recording all observations of wildlife. Find as many animals as possible (birds, mammals, insects, arthropods). Dig up some soil with a trowel and look under rocks to extend observations to wildlife to be found in the ground. Be cautious of snakes that may be under large rocks or logs. Magnifying glasses may be used to examine small organisms. Ask students to complete Student Handout 2 (see Table 1) or one of your own design during their observations.

Table 1

List of Wildlife Found

Check off each one observed and add new ones.

Partial List of Animals

- crow
- hawk
- owl
- robin
- oriole
- blue bird
- woodpecker
- creeper
- snail
- squirrel
- raccoon
- opossum
- spider
- millipede
- centipede
- earthworm
- pill bug/sow bug
- fly
- vole
- ground hog
- bee
- warbler
- peewee
- tree mouse
- nuthatch
- ant
- mosquito

2. Using the Life History Notes, Student Handout 1, found at the end of this module and reference books such as the Golden Guide Series. Ask each group to select three animals and fill in an Individual Wildlife Description chart for each using the source materials. See Student Handout 3 (see Table 2).

Table 2

Individual Wildlife Description Chart (Sample)

Animal: ____

Habitat	Physical Description of animal	Feeding Habits

Optional activities:

3. *Optional:* ***Small animals*** *that live in the undergrowth often run freely over the ground often without being noticed noticed. They can be sampled to determine their number and type. Two sampling procedures should be used.*

   A.) ***Undercover Sampling:*** *Provide students with 6 - 10, thirty centimeter square (about one foot square) pieces of heavy cardboard or wood. Have the students place the squares equally spaced in a line starting in a tree or shrub area and moving into an open area. The squares should be left undisturbed. They should be in an out of the way area or placed for only overnight. Lift the squares slowly with a stick. Check the animal life using the squares for cover the next day. Tally number and type at each site. Compare the data from each site. What trends exist* *between sites, differences and similarities?*

B.) ***Pit Sampling:*** *Provide students with 3 - 6 large coffee or juice cans. Make sure that the sharp edges are covered with tape to avoid cuts. Place the cans, buried to the top rim in the ground, at selected locations as in A) or in concealed undergrowth. The buried cans should be checked twice a day. The small animals collected should be released as soon as tallied because they will starve quickly if they are prevented from feeding. When removing the can from the ground, do not touch the animals and when releasing them, use caution. Lay the can on its side in the underbrush during the release. You may wish to keep the cans in the ground overnight, making tallies in the morning and returning the cans to the ground sites in the late afternoon or evening.*

Sample ***plant*** *number and types using the procedure below*

C.) ***Area Sampling:*** *Set up 3 - 6 square areas, one square meter in size (or smaller area), set off by stakes and string (or clothes hangers stretched into a square), as described in A) above. Make tallies of numbers and types of plants included in each area found in the square. Plants can be taped to paper to substitute for names. Remove only one specimen of each species, otherwise you will take too much from the area. Compare the areas selected. Relate results to results of A) or B) sections. You might have students check for differences in areas near footpaths and undisturbed areas.*

4. *Optional: Check shrubs for organisms that live on them. Spread a sheet of white plastic or a white bed sheet on the ground beneath a shrub. Gently brush and shake the shrub with a long stick. Transfer into boxes with a spoon the organisms that fall on to the sheet. Slugs and snails, found near bushes and plants can be collected by hand and put in boxes that contain pieces of the plants on or near which these animals were found.*

INVENTING THE IDEA PHASE

TO THE TEACHER:

During this phase of the learning cycle the teacher will play a more directive role. At this time the teacher may wish to refer to notes, background information, etc. The teacher may use inquiry techniques to reinforce exploration activities or simply demonstrate and explain some of the ideas involved in observed actions in a forest community especially those relating to interaction and interdependence.

Students who were not able to answer the problems or events given in the exploration should be led to an appropriate response at this time.

Trees that have decayed inside and have become partly hollow provide homes for many different animals. All trees harbor a variety of plant and animal life. Different kinds of animals prefer different levels in a single tree. The tree's leafy crown, upper canopy, may be occupied by birds such as blue jays, wrens,grackles, sparrows, and perhaps hawks and owls in rural areas.

The understory, lower tree canopy, begins with the larger, lower branches. This area may be inhabited by a great variety of birds. Woodpeckers will bore out their holes high off the ground in a dead or dying tree. Owls, bluebirds, and several other species re-use the abandoned woodpecker holes. Squirrels make their summer nests high in a tree.

The "first floor", shrub layer, is the trunk of the tree extending from the ground to where the branches begin. Insects can be found here. If a tree is hollow, this level may be the home of raccoons, chipmunks, and squirrels (in winter). Extract a piece of bark from a dead tree to enable the students to see more insects and tunnels made by insect larvae. Spiders will sometimes be found on the tree trunk. Mosses will be found on the sides of the trunk or exposed roots away from direct sunlight.

The ground layer around the roots where soil is loose will provide homes for rabbits, mice, and moles. Many insects can be found in the soil as well as earthworms and snails. There are animals in the forest soil that eat the remains of dead plants and animals. The forest floor contains a whole world of tiny living creatures present in the soil. In addition to the microscopic bacteria and fungi that start the decay process, decaying matter is eaten by animals such as worms, mites, centipedes, millipedes, certain spiders, and both larval and adult insects.

EARLY CHILDHOOD ACTIVITIES

Materials:

- some regular sized cookies for each child
- one spoon for each group of 2-4 students
- one garbage bag of leaf litter (preferably from the forest floor)
- jars or margarine containers to hold specimens found in the leaf litter, one for each group.
- at least one magnifying glass for each group of 2-4 students
- reference books on insects and other small animals likely to be found in leaf litter
- marking pen
- garbage bagful of leaf litter, preferably from the forest floor
- 4 to 8 sheets of newspaper
- Life History Notes found in Student Handout 1 at the end of this module

Involve the students in the following activities:

1. Give each child a cookie and ask him/her to take a bite of the cookie. Examine what has happened to the cookie.

   Ask, will the cookie grow back? How long would it take to eat the whole cookie? After answers are given, hold up one cookie and ask, "How long would it take to eat the cookie if everyone here took a bit of this cookie at the same time?" Ask the students "What do ants eat?" "How long would it take ants to eat your cookie?" "What do you think would be a treat to a forest animal, such as an owl? a raccoon?"

Use the Life History Notes found in Student Handout 1 to describe preferred foods for the Great Horned Owls and raccoons. Relate the discussion to the **Exploration** activity.

2. Dump a garbage bag of leaf litter (preferably from the forest floor) on the floor in several piles on newspapers. Divide students into groups of 2-4 and have them pick through the leaf litter. Any organisms found can be lifted up with a spoon (they may be delicate and easily damaged if not picked up carefully) and placed in a jar or plastic margarine container. A magnifying glass can be used to aid the hunt for organisms in the leaf litter.

   Students should count the number of organisms found. Each group can fill in a class bar graph constructed with colored construction paper which shows the number of a specific organism found by each group. See Student Handout Sheet #4, titled "How Many Animals Did We Find in Leaf Litter?".

   Students should discuss what the animals, found in the leaf litter, eat. Where possible, animals found should be identified using a reference book, such as the Golden Guide series. The students may make a drawing or bulletin board which has leaves on it and construction paper animals dispersed through it feeding on parts of the leaf litter.

3. Provide a closure to the *Invention Phase* by briefly stating in the student's level of language that animals and plants are dependent on each other. When parts of a natural area are disturbed many organisms are affected, not just the originally disturbed living things.

MIDDLE CHILDHOOD ACTIVITIES

TO THE TEACHER :

The Life History Notes, Student Handout 1, can be used to support the following activities. Following each activity, students should describe their products and the teacher should relate the variety of student ideas to forest community interaction concepts -- forest layers (strata), animal and plant interrelationships, competition for light and food, symbiosis, habitat, foraging area, niche, protective coloration or in general camouflage, and food source.

Materials: for the class

- binoculars (if available)
- writing and drawing materials
- large sheets of paper, construction paper or computer printout
- Life History Notes found in Student Handout 1 at the end of this module
- reference books on animals
- reference book on animal tracks
- plaster of paris, bowl for mixing plaster, cardboard “collars” to pour plaster into

Involve the students in two or more of the following activities:

1. On a large sheet of paper ask students to draw a forest area. This should include forest boundaries including such things as a farm, lake, stream, or highway. Then ask students to select animals (10 or more) of their choice and show locations where those animals are found on their maps.

   On a separate sheet of paper have students describe each animal's habitat. Reference books and Life History Notes, Student Handout 1, can be used. Ask students to share their work and relate their ideas to forest community interaction concepts. Describe information to the students provided in the previous teacher note.

Choose one of the following optional activities if time is available.

2. *Optional: Ask students to draw a tree "apartment" including animals of their choice. They will include a "key" which gives facts for each animal. Ask students to share their work and relate their ideas to forest community interaction concepts. Describe information to the students provided in the previous teacher note.*

3. *Take a neighborhood field trip or school grounds excursion to look at trees or other natural areas. Have students predict what animals they might discover and where they might live in the tree strata. Use binoculars to help look for tree inhabitants. Don't forget organisms in streams if available. Ask students to share their observations and relate them to forest community interaction concepts. You may want to use copies of Student Handouts 2 and 3.*

4. *Optional: Students may select one wildlife animal and depict its habitat and foraging activities in drawings. Use the wildlife notes at the end of the module or school library as a resource. Ask students to share their work and relate their ideas to forest community interaction concepts. Describe information to the students provided in the previous teacher note.*

5. *Optional: Find an injured tree in which sap is seeping, especially easy in spring. Observe insects and changes near this injury over the day or week and record observations in notebooks. Include number, type, and activity present along with the time and date. Make a drawing during each observation. Ask students to share their work and relate their ideas to forest community interaction concepts. Describe information to the students provided in the previous teacher note.*

6. *Optional: Locate animal tracks and footprints in a muddy area or along a stream bank. Make plaster casts of the prints. Fit a two inch high cardboard collar around some clear, deep tracks. Mix plaster of paris and water in a somewhat flexible plastic bowl and pour into collared area (after plaster hardens, crack plaster up inside bowl and remove it).*

   Wait until plaster cools and sets to remove the cast. The cast will show the shape of the animal's foot. Footprints can be identified using a reference book. Ask stu-

dents to share their work and relate their ideas to forest community interaction concepts. Describe information to the students provided in the previous teacher note.

7. Provide a closure to the *Invention* by briefly defining the concept of forest community interaction and interdependence and illustrating with the experiences above.

EXPANDING THE IDEA PHASE

TO THE TEACHER:

In the final learning cycle phase the student must use and apply facts, concepts and relationships concerning forest community interactions. Students should refer to cumulative information notes, fact sheets, etc. New contexts and different ways of looking at the ideas explained in the earlier part of the lesson should now be attempted. Following this phase, the teacher should check student outcomes with a quiz, performance test, and/or discussion.

EARLY CHILDHOOD ACTIVITIES

Materials: for the class
- pictures of damaged forests (e.g. from gypsy moth, pine beetle, locust, fire blight)

Involve the students in one or more of the following activities:

1. Take the students outside on the school grounds to a tree or a stand of trees. Ask the following types of questions. In addition, ask the students to support their responses with evidence they can find observing the tree.

    - How does the size and shape of this tree compare with other trees?
    - What effect does the size and shape of a tree have on the life it supports?
    - What type of animal uses the following tree part for food or shelter - bark, underbark (cambium, sapwood) leaf, flower, seed, branch, and root. (See earlier Teacher Note). Ask the students to relate the variety of observations to ideas of forest community interaction concepts.

2. *Inform the class that insects and forest animals use trees to live in and as food .*

    * *What happens when an insect bites you?*
    * *What happens when insects and animals bite, peck, claw, or rub trees?*
    * *How long might it take to damage this tree if all the insects decided to have breakfast, lunch, and dinner at the same time in this tree? (The tree would be severely damaged in a few hours)*

    Ask the students to relate the variety movements and locations to ideas of forest community interaction concepts.

3. *Inform the class that one of the responsibilities of the forest managers is to protect the trees from being destroyed by insects, animals, and also from diseases caused by very small organisms. What would happen if these things are not controlled? How can/do people prevent forests from being injured or eaten? If possible, show pictures of forests damaged by insects, animals, and diseases. Ask the students to relate the variety of damage to ideas of forest community interaction concepts.*

MIDDLE CHILDHOOD ACTIVITIES

Materials: for the class

- notebooks and writing materials
- *a few apples*
- *a few pine cones filled with peanut butter (holes drilled in small logs can substitute) This can be made in the classroom as part of the lesson.*
- *a few pine cones filled with suet This can be made in the classroom as part of the lesson.*
- *1 lb bag of birdseed*
- *50 holly leaves or thistle leaves which have been attacked by leaf mining insects.*

Involve students in one of the following activities:

1. Animals movement for a school or home assignment

Have students locate a specific animal species near their home and observe it. They should not disturb or move the animal from where they found it. The movements animals make when observed may not be those they most frequently make, so students should try to observe animals moving around their natural outdoor habitats. Some of the animals they might observe are;

* Gnats or swallows on a warm evening.
* A pond skater on the surface of a pond.
* A snail or slug in the garden after a rain.

* Ants on a path.
* Caterpillars on leaves and twigs.
* A butterfly over a flower or vegetable patch.

* Flies on cow pats.
* A house fly on a window pane.
* Earthworms trying to burrow into the soil.

* Spiders on a tree.
* Sowbugs (pillbugs) beneath rocks.
* Beetles walking over the ground surface.
* Skunks or raccoons investigating garbage cans.

Ask the students to make notes while they are observing. In their notes, students should describe how and where an animal moves. They should describe its movement (fluttering, darting, gliding, slithering, etc.). How much time does an animal spend moving in a five-minute period? If watched for a second and third five-minute period, is the amount and type of movement the same? Each student can contribute to a class bar graph similar to the one below.

Figure 1. ANIMAL MOVEMENT

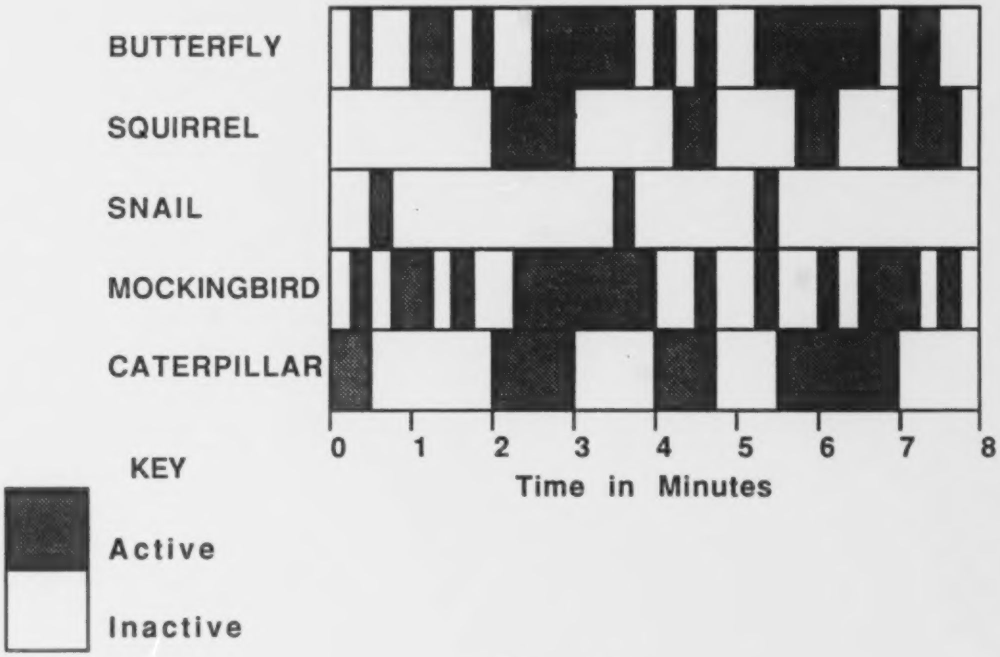


Figure 4
Animal Movement

Students also can indicate where each animal typically would be found when outdoors (which part of the tree strata?). Ask the students to relate the variety movements and locations to ideas of forest community interaction concepts. Ask the students to summarize in a paragraph, drawing, or by graphing the movement of one animal.

2. *Optional: Select a variety of foods, such as apples and pine cones filled with peanut butter, suet, and seeds. Suspend some foods from a tree on the school grounds near the classroom. Scatter others on the ground beneath the tree.*

   A. *Record the placement and number of the initial distribution.*
   B. *Take readings at morning, mid-day, late afternoon.*
   C. *What foods are missing? Which ones have been nibbled on? Which ones were disturbed?*

D. At the time of observation, if wildlife is present quietly watch. Record behaviors, draw or write.

E. If some of the bait does attract wildlife, set up a simple experiment to answer the question, "Is all bait equal for attracting wildlife?" To find out, select 3 baits -- 3 suspended from a tree and 3 put on the ground, distribute them an equal distance apart. Which disappears first? Which is not touched, etc.? Discuss results, take data and graph results of observations. Ask the students to relate the variety movements and locations to ideas of forest community interaction concepts.

	Number of times observed		
Activity	Morning	Midday	Afternoon

Figure 3
Feeding Activity Record Sheet

3. Optional: Collect 50 holly leaves or thistles which show evidence of attack by leaf mining insects (student may be able to contribute some specimens). Have students draw leaf and trace routes of tunnels. Does there appear to be any similarity in these routes or is the direction of movement erratic. For example, do they follow leaf veins, occur only at the outer leaf edges, etc. Ask the students to relate the variety movements and locations to ideas of forest community interaction concepts.

SUMMARY

This module living community interactions (interaction, interdependence) relationships to forests and wildlife. The teacher may wish to summarize by having students make or compose stories, poems, or illustrations of plants and animals depicting or describing community interactions.

EVALUATION

The teacher can make ongoing evaluations and include a quiz involving matching of type of interaction or interdependence to plants and animals involved. Student reports and research projects also can serve as evaluative components. Culminating activities might include a Jeopardy type game concerning facts about select studied plants and animals, perhaps those in the Life History Notes in Student Handout 1 included with this module. Provide cards for the activity or have students construct cards.

STUDENT HANDOUT 1

LIFE HISTORY NOTES

Life History Notes -- Wild Turkey

Scientific Name: *Meleagris gallopavo*
Mating: Polygamous; breeds in April
Nesting Period: April 15-June 15; hatching peak May 15-June 15.
Clutch Size: 8-16; average 12
Egg Color: Pale creamy white to creamy beige with small, pale chocolate or reddish brown spots
Egg Shape and Size: Oval, 2 1/4 x 1 3/4 in (57 x 44 mm)
Incubation and Development: 28 days incubation; leave nest in 24 hours; first flight at 2 wks.; look like adults at 16 wks.; females sexually mature at 1 yr.; males at 2 yrs.l 1 brood per year
Adult Weight: Male 8-24 lb. (3.6-10.9 kg.), average 17 lb. (7.7 kg.); female 7-16 lb (3.2-7.3 kg.), average 11 lb. (5 kg.)
Adult Body Length, Including Tail: Male 42-28 in. (107-122 cm); Female 32-38 in. (81-97 cm)
Adult Wingspread: Male 42-48 in (107-122 cm); Female 34-39 in (86-99 cm), average 37 in. (94 cm).
Life Expectancy: Male, average 2 yrs.; Female, average 3 yrs.; maximum 10 yrs.
Movement: home range 2 sq. mi. (518 hectares).
Feeding Period: daytime
Foods: Acorns, beechnuts, dogwood fruits, grape, greenbrier, many other shrubs, insects, leaves and fruits of many herbaceous plants
Description: An upland gamebird, it's 3-4 ft. tall and weights up to 24 lbs. It has a slim build, long neck, and nearly featherless head. The body feathers look drab brown from far away, but are iridescent when seen close up in good light. The large tail is brown with a black band near the tip. Adult males (gobblers) have a reddish head, a long, tasseled "beard" dangling from the breast; black-tipped breast feathers, and spurs on the legs. Hens have a bluish head, usually no beard, buff-tipped breast feathers, and no spurs.
Living Area: Wild turkeys were found all over eastern forests before settlement. Hunting and cutting down of forests eliminated them from many areas after settlement. Turkeys have been reestablished as forests have regrown. An average of two turkeys per square mile is found in the spring now. Turkeys prefer mature forests and don't like much disturbance from humans.
Note: Information for the Life History Notes above has been obtained from the Ohio Department of Natural Resources, Division of Wildlife's Publication, Life History Notes.

Life History Notes -- Opossum

Scientific Name: *Didelphis marsupialis*
Mating: Polygamous
Breeding Period: January-October; February-March (peak)
Gestation: 12-13 days Birth Period: February-November
Litters Per Year: 1-3
Litter Size: 5-25; average 9
Birth Weight: 1/15 oz. (1.9 grams)
Young Remain in Mother's Pouch: 2 mo.
Eyes of Young Open: at 2 mo.
Young Leave Nest: at 3 mo.
Young Weaned: 15-20 in.(38-51 cm.)
Breeding Age: 1 year
Adult Weight: 4-15 lb. (1.8-6.8 kg); average 5 lb.(2.3 kg.)
Adult Body Length: 15-20 in. (38-51 cm.)
Adult Tail Length: 9-20 in. (23-51 cm.)
Life Expectancy: 1-2 yrs.; maximum 7 yrs.
Movement: home range 15-40 acres (6-16 hectares), but individuals may wander widely, especially in fall
Feeding Period: Mostly at night
Foods: Omnivorous--carrion, insects, fish, amphibians, reptiles, eggs, fruits, vegetables, and nuts.
Description: Adults are about the size of a large house cat, with coarse, grizzled grayish fur; a long, naked, scaly tail; naked ears; and a pink nose at the tip of a long, pointed snout.
History: The opossum is the oldest and most primitive mammal in North America. Its ancestors roamed the giant fern forests 70 million years ago. It is small-brained, plodding, and unspecialized yet it has survived. The opossum wasn't common before pioneer settlement. Today it is very common. It prefers farmland, especially wooded pastures near a stream, lake, marsh, or swamp. It also lives in urban areas. It especially likes areas where there are mixed woods, wetlands, and farm land.
Living Area: Its den is usually in a wooded area near water. It can make a den in almost any place where it can stay dry and safe. It will use other animals deserted dens, brush piles, tree holes and openings under old buildings. Development: The opossum is the only marsupial in North America. The babies are pea-sized and undeveloped. The newborn crawls blindly to the mother's pouch, climbs inside, and attaches to one of 13 nipples in the pouch and hangs on for 2 mo. so it is constantly fed. If a newborn doesn't find a nipple, it dies. At 3 mo. the young leave the pouch for short periods, hitching a ride on their mother's back.
Protecting Itself: The opossum will sometimes bare its 50 teeth and hiss loudly. Usually it rolls over and plays dead.
Note: Information for the Life History Notes above has been obtained from the Ohio Department of Natural Resources, Division of Wildlife's Publication, Life History Notes.

Life History Notes -- Eastern Gray Squirrel

Scientific Name: *Sciurus carolinensis*
Mating Behavior: Polygamous
Breeding Period: December-January and May-June
Gestation: 44 days
Litters per year: 1 or 2
Litter Size: 3-5
Birth Weight: 0.42 oz. (12 grams)
Eyes of Young Open: at about 36 days
Young Leave Nest: at 7-8 weeks
Young Weaned: at 10-12 weeks
Breeding Age: Females -- 6-8 mo. Males -- 9-11 mo.
Adult Weight: 12-24 oz. (340-680 grams)
Adult Body Length: 8-10 in. (203-254 mm).
Adult Tail Length: 7.8-10 in. (198-254 mm.)
Life Expectancy: 1 year average, maximum of 10 years
Movement: Female--average home range of 8 acres, Male-- 17 acres
Feeding Period: mostly 8-10:00 a.m. and 2-4:00 p.m.
Foods: nuts, seeds, and fruits of hickory, beech, oak, black walnut, tulip tree, sugar maple, flowering dogwood, buckeye, wild grape, pawpaw, persimmon, butternut, and black cherry; also insects.
Description: overall grayish color, bushy tail, whitish belly, white-tipped tail hairs, in summer it is yellowish-brown along sides and on feet.
Before Settlement: There were many Eastern Gray Squirrels in eastern forests before settlement by the pioneers. They often ruined the crops planted by pioneers so sometimes a bounty was paid for squirrel skins. As hardwood forests were cut down squirrel populations decline and restrictions on hunting them began.
Today's Living Areas: Eastern Gray Squirrels live in forestlands with a fall population density of about 1 squirrel per acre. They are also found in cities and parks with large hardwood trees. They like to live in areas where there are oak, hickory, tulip tree, beech, maple, sassafras, and flowering dogwood. Timber management practices which create broken stands of middle-aged and mature trees provide the most food and den sites for them. They have both leaf nests and tree dens. Leaf nests are made of twigs and leaves, are 1 - 2 feet in diameter, and have an interior space 4 - 5 inches across. They often are near a grapevine growing up a tree. The dens are at least 20 ft. above the ground, in a hollow trunk or limb at least 15 in. in diameter. The entrance is 3 - 4 in. wide; the hollow inside space is 2- 3 ft. deep and lined with leaves.
Growing Up: Squirrels grow up slowly. At about 7 weeks they begin to taste green food, bark, and other solids. Spring litters are often still together in late fall, at about 9 mo. old. They eat their own weight in food every week. They don't remember where they bury nuts and acorns, but use their good sense of smell to find them in winter. Because they don't find many of the nuts and acorns they bury, lots of these sprout and grow. The Eastern Gray Squirrel is a major tree planter in the hardwood forest.
Note: Information for the Life History Notes above has been obtained from the Ohio Department of Natural Resources, Division of Wildlife's Publication, Life History Notes.

Life History Notes -- Raccoon

Scientific Name: *Procyon lotor*
Other Common Names: Coon, Ringtail
Mating: Monogamous. After mating the male isn't interested in family life and leaves all responsibility for raising the young to the female.
Breeding Period: March-June, peak in April-May
Litters Per Year: 1
Litter Size: 2-7; average 4
Birth Weight: 2 1/2 oz. (71 grams)
Eyes of Young Open: at 3 weeks
Young Leave Nest: at 2 mo.
Breeding Age: 1 year
Adult Weight: 5-35 lb (2.3-15.9 kg)
Adult Body Length: 18-18 in. (46-71 cm)
Adult Tail Length: 8-12 in. (20-30 cm)
Life Expectancy: 3-4 yrs.; maximum 13 yrs.
Movement: home range 1/2-1 mile (0.8-1.6 km.)
Feeding Period: Mostly at night
Foods: Omnivorous--fruits, nuts, grains, eggs, insects, crayfish, frogs, and mice. It eats many things partly because it can crush hard foods like acorns and shellfish with its large molars. It often forages for food in water and sometimes dunks its food before eating. Often it eats its food without washing it. **Description**: Medium-sized mammal with grizzled gray-black fur, black face mask, and alternating rings of black and yellowish-white on its bushy tail.
Living Areas: Pioneers found many raccoons in the forests. It likes large, hollow trees in woods for dens but will also use ground burrows, rock crevices, drain tiles, and old buildings. Raccoon are sociable and often den with others. They don't hibernate but will nap for long periods of time in a secure shelter if it is very cold.
Sounds: Raccoons make many sounds. Females will twitter to reassure their young. Males will growl and snarl if they are angry. Raccoons also howl.
Note: Information for the Life History Notes above has been obtained from the Ohio Department of Natural Resources, Division of Wildlife's Publication, Life History Notes.

Life History Notes--Ruffed Grouse

Scientific Name: *Bonasa umbellus*
Other Common Names: More than 100 names are recorded including pat, partridge, wood pheasant, mountain pheasant, and drummer.
Mating: Promiscuous; peak activity mid-April. The male Ruffed Grouse performs spring mating displays on a platform, usually a log, in a 10 to 30 acre activity center which he normally occupies all his life. Standing on the platform, he beats his wings, slowly at first, then ever faster to produce a "drumming," a hollow, low-pitched sound like an engine starting up at a distance.
Nesting Period: April-May; peak hatch in late May
Clutch Size; 9-14 eggs; average 10
Egg Color: Milky white to cinnamon buff, usually plain but often with reddish spots.
Egg Shape and Size: oval, 1 1/2 x 1 1/8 in (38 x 29 mm.)
Incubation:l 24 days
Young: Leave nest when down is dry; first flight at 2 wks.; resemble adults at 16 wks.; sexually mature at 10-12 mo.
Number of Broods per Year: 1; if first next disrupted, may re-nest and lay about 7 eggs.
Adult Weight: 16-27 oz. (454-765 grams)
Adult Body Length, Including Tail: 16-19 in. (41-48 cm)
Adult Wingspread: 22-25 in. (56-64 cm)
Life Expectancy: Average about 1 year; maximum 8 years
Movement: Home range 20-40 acres (8-16 hectares)
Feeding Period: Mostly in early morning and late afternoon
Foods: Young grouse eat insects and berries; adults eat parts of more than 100 wild plants including bedstraw, cinquefoil, avens, greenbrier, grape, dogwood, ferns, sumac, bittersweet, poison ivy, cherry, hawthorn, hophornbeam, blueberry, blackberry, raspberry, viburnum, oak, aspen, and hazelnut; they don't usually eat any cultivated crops.
Description: A large, chicken-like bird with a fan-shaped tail. They can be brown or gray. The black ruff on each side of the neck is most noticeable in the male. A black band, extending across and near the end of the tail, is interrupted with in most females and a few males. A fully developed central tail feather will measure (when plucked) more than 6 1/4 in. in 99% of males; it is usually shorter in females.
Living Areas: The Ruffed Grouse lived in the forests when the settlers came. When much of the forest was removed only small numbers of grouse survived. Ruffed Grouse are coming back to areas where forests are regrowing. They like stands of mixed species of hardwood shrubs, saplings, and brush-vine tangles. They also like moist areas with dense clumps of shrubs interspersed with lush herb growth and young forest stands of mixed hardwoods. They especially like areas with a stream or swamp.
Note: Information for the Life History Notes above has been obtained from the Ohio Department of Natural Resources, Division of Wildlife's Publication, Life History Notes.

Life History Notes -- Great Horned Owl

Scientific Name: *Bubo virginianus*
Other Common Names: Hoot owl, king owl, eagle owl, cat owl, chicken owl, horned owl, Virginia horned owl, woods witch
Mating: Monogamous; peak activity in January
Nesting Period: Early February to mid-May
Clutch Size: 1-5 eggs; average 2
Egg Color: White to dusky white
Egg Shape and Size; roundly oval; 2.2 x 1.9 in (56 x 48 mm)
Incubation: 32-35 days; peak of hatch in early to mid-March
Young: Leave nest in 5-7 wks.; first flight at 9-10 wks.; resemble adults at 2 mo.; sexually mature at 2 yrs.
Number of Broods per Year: 1; rarely re-nests if disturbed
Adult Weight: Male, 2 1/2 to 3 1/2 lbs (1.1-1.6 kg.); average 3 lb. (1.4 kg.); Female, 3 to 4 1/2 lbs. (1.4-2.0 kg.), average, 3 3/4 lbs. (1.7 kg.)
Adult Body Length, Including Tail: Male, 19-23 in., (48-58 cm); Female 22-25 in. (56-64 cm).
Adult Wingspread: Male, 50-55 in. (127-140 cm); Female, 50-62 in. (127-157 cm)
Life Expectancy: approximately 50% of Great Horned Owls hatched will die during their first year. Surviving adults average 6-7 yrs.; Maximum age in wild is 15 yrs.; Captive birds have lived over 50 yrs.
Movement: Home range varies a lot according to season, habitat, and availability of prey; generally 1-6 sq. miles per pair. Great Horned Owls don't migrate. Young leave in fall, but generally locate within 30 miles of parents' territory. Northern birds may move south during severe winters.
Feeding Period: Mostly at night, but will also hunt by day
Foods: Most widely varied diet of all North American birds of prey; including rats, mice, skunks, bats, shrews, moles, squirrels, rabbits, cats and other mammals; also songbirds, gamebirds, waterfowl, hawks, owls, snakes, turtles, frogs, fish, crayfish, worms, and insects.
Description: It is the largest "eared" owl in North America. It is generally brown, spotted with darker brown, and heavily barred. The underparts are somewhat lighter in color, with a conspicuous white throat patch. The legs and feet are large; extremely well developed, and almost fully feathered. The great curved talons are thick at the base, tapering to sharp points, and can inflict severe damage. The large eyes are bright yellow and highlighted by a black facial rim. The sexes are identical in coloration but the female is bigger.
Living Areas:l It can adapt to many areas where it can find suitable nest sites. Maximum densities occur in heavily forested areas, but open woodlands, orchards, parks, marshes, swamps, and lakeshores are also used.
Note: Information for the Life History Notes above has been obtained from the Ohio Department of Natural Resources, Division of Wildlife's Publication, Life History Notes.

Life History Notes -- Striped Skunk

Scientific Name: *Mephitis mephitis*
Other Common Names: Polecat, Wood Pussy
Mating: Polygamous
Breeding Period: February-March
Gestation: 63 days
Birth Period: May
Litters Per Year: 1
Litter Size: 2-10; average 6
Birth Weight: 1 oz. (28 grams)
Eyes of Young Open: at 4-5 wks
Young Leave Nest: at 6-8 wks
Young Weaned: at 6-7 wks
Breeding Age: 1 year
Adult Weight: 6-10 lb (2.7-4.5 kg); average 8 lb. (3.6 kg)
Adult Body Length: 13-18 in (33-46 cm)
Adult Tail Length: 7-10 in (178-254 mm)
Life Expectancy: 8-10 yrs.
Movement: I home range 10 acres (4 hectares)
Feeding Period: at night
Foods: Omnivorous -- mice, lizards, frogs, fish, crayfish, insects, grubs, eggs, fruits, and carrion
Description: It is about the size of a house cat, with a large body, small head, and short legs. The hair is long and black, with a broad white patch on the head and shoulders. Two white lines forming a "V" from the shoulder area may extend part way or all the way to the base of the bushy tail.
Living Area: The Striped Skunk has increased in numbers as the forest has been cut down. It prefers a semi-open living area of mixed woods, brush, and open grassland within two miles of water. Its den may be in a ground burrow or beneath a boulder, rock pile, wood pile, or abandoned building. Almost any dark, dry, sheltered site will do. In December females den up, sometimes 8 - 10 to a den. Males are more solitary. During periods of extreme cold they may stay inside for days at a time, but a warm period will bring them out in search of food.
Habits: Young skunks are taught to hunt by their mother, and in late June or July are seen walking single file behind her at dusk, off for an evening's feeding and training. They make a variety of sounds; they can twitter, screech, growl, churr, coo, and whistle. They don't hibernate.
Scent: The Striped Skunk has well-developed scent glands, located at the base of the tail. When seriously threatened, the skunk can squirt the musk from these glands with great accuracy up to 15 feet. Even a gentle breeze can carry the scent more than a mile. The musk is yellowish, has an acrid, stinging odor, and sticks like glue. It is painful to the eyes. Tomato juice is the best treatment if you have been sprayed. Scented clothing is best burned.
Note: Information for the Life History Notes above has been obtained from the Ohio Department of Natural Resources, Division of Wildlife's Publication, Life History Notes.

Life History Notes -- Eastern Cottontail Rabbit

Scientific Name: *Sylvilagus floridanus*
Mating: Polygamous
Breeding Period: February-September; peak of activity, April-May
Gestation: 28-30 days.
Birth Period: Early March-late September; peak May-June
Litters per Year: 2-5; average 3
Litter Size: 2-10; average 5
Birth Weight: 3/4 to 1 1/4 oz (21-35 grams)
Eyes of Young Open: at 7 days
Young Leave Nest: at 2 wks
Young Weaned: at 3 wks.
Breeding Age: Females at 3 mos.; Males at 6 mos.
Adult Weight: 2-4 lb. (0.9-1.8 kg.); average 2 1/2 lb. (1.1 kg.)
Adult Body Length: 14 1/4 to 16 3/8 in (36-42 cm)
Adult Tail Length: 1 1/2 to 2 3/4 in (38-70 mm)
Life Expectancy: average less than 1 year; maximum 4-5 years
Movement: Home range of females 4 acres (1.6 hectares); Males 10 acres (4.0 hectares)
Feeding Period: Early morning and early evening
Foods: Wide variety of succulent plants such as clover, dandelion, plantain, lambsquarter, and ragweed; winter foods include ear corn, dry hay, and bark of tree saplings, raspberry, blackberry, and multiflora rose.
Description: Brownish or grayish body with long ears, short, cottony-white tail, and usually a rusty patch on the nape of the neck. Unlike rodents, the cottontail has 2 pairs of upper incisor teeth--a small pair directly behind the prominent front ones.
Living Area: Cottontails were not abundant in the Eastern forests when the first European settlers arrived. As agriculture opened the forest canopy, favorable habitat expanded and rabbit numbers increased. Cottontails are almost everywhere today. Population densities vary from 4 to 50 per acre. Cottontails like open lands bordered by thickets and brushy areas with ground burrows and holes. Such a living area provides fast escape from predators and protective cover during bad weather. Travel lanes are also important, as rabbits like to feed close to cover. These may be brushy fencerows, multiflora rose hedges, young pine plantings, standing corn rows, brushy stream banks, or dry drainage ditches. Their nest can be in open fields, shrubby pastures, unkept orchards, hay fields, young pine plantations, even on mowed lawns. The nest is a shallow depression in the ground, 4-6 inches deep and 4-5 inches in diameter. The female lines it first with dry grasses, then with fur from her body. The male takes no part in caring for the young, which are born blind, deaf, and hairless. The female visits the nest often to nurse the young; although they leave the nest at about 2 weeks. of age, they continue to nurse occasionally for another week.
Note: Information for the Life History Notes above has been obtained from the Ohio Department of Natural Resources, Division of Wildlife's Publication, Life History Notes.

Life History Notes -- Muskrat

Scientific Name: *Ondatra zibethicus*
Other Common Names: Marsh rabbit, marsh hare, rat
Mating: usually monogamous, sometimes polygamous
Breeding Period: February-August; peak in April Gestation: 22-30 days
Birth Period: March-September; peak in May
Litters Per Year: 2-3; usually 2 Litter Size: 1-11; average 6 Birth Weight: 3/4 **oz. (21 grams)**
Eyes of Young Open: at 15 days
Young Leave Nest: at 15 days
Young Weaned: at 14 wks
Breeding Age: 10-12 mos
Adult Weight: 2-5 lb (0.9-2.3); average 3 lb (1.4 kg)
Adult Body Length: 12 in (30 cm)
Adult Tail Length: 10 in (25 cm)
Life Expectancy: less than 2 yrs; maximum 4 yrs
Movement: home range radius 100-200 yds.(91-183 meters) from house or den
Feeding Period: Mostly at night; often during day
Foods: Stems, roots, bulbs, and sedge; also clams, snails, mussels, insects, crayfish, fish, frogs, and corn
Description: The muskrat is stocky, with a broad head, short legs, small yes, and short ears that barely extend above its fur. The fur is rich dark brown on the upper parts and silver-tipped on the belly; the guard hairs are long and coarse and the underfur is dense and waterproof. It has a naked, scaly tail which is flattened from side to side.
Living Area: It is found wherever there are marshes, swamps, ponds, lakes, and ditches. It likes an area with still or very slowly running water with vegetation both in the water and along the banks. Cattail, burreed, and bulrush marshes are best. Muskrats build their houses or dens from available vegetation. They build a cone shaped house 6-8 ft. wide and 2-4 ft. tall. The house is watertight and provides the muskrat family with a dry nest in summer and a constant temperature in winter. Along streams, and where water levels are low, some muskrats dig den burrows in the banks. Feeding rafts-- piles of plant stems that serve as above-water feeding platforms-- are sometimes found near muskrat homes. Muskrats do not store food for the winter and will eat nearly anything when ice interferes with their normal feeding. At such times they will eat dead carcasses of fish, waterfowl, or nearly any other kind of animal, including muskrats.
Personality: Muskrats quarrel, especially when there are too many in an area. When they fight they may squeal, squawk, snarl, moan, and chatter their teeth. When there are too many muskrats in an area the marsh habitat is damaged and they become susceptible to epidemics. They have many natural enemies, mink, weasels, foxes, snakes, hawks, and owls. But, the continuing draining and destruction of wetlands is their worst enemy.

Note: Information for the Life History Notes above has been obtained from the Ohio Department of Natural Resources, Division of Wildlife's Publication, Life History Notes.

STUDENT HANDOUT 2

Wildlife Inventory

List of wildlife found - check off each one observed and add new ones.

Partial List of Animals

- crow
- hawk
- owl
- robin
- oriole
- blue bird
- woodpecker
- creeper
- snail
- squirrel
- raccoon
- opossum
- spider
- millipede
- centipede
- earthworm
- pill bug/sow bug
- fly
- vole
- ground hog
- bee
- warbler
- peewee
- tree mouse
- nuthatch
- ant
- mosquito

STUDENT HANDOUT 3

Individual Wildlife Description

Animal:____

Habitat	Physical Description of Animal	Feeding Habitats

Animal:____

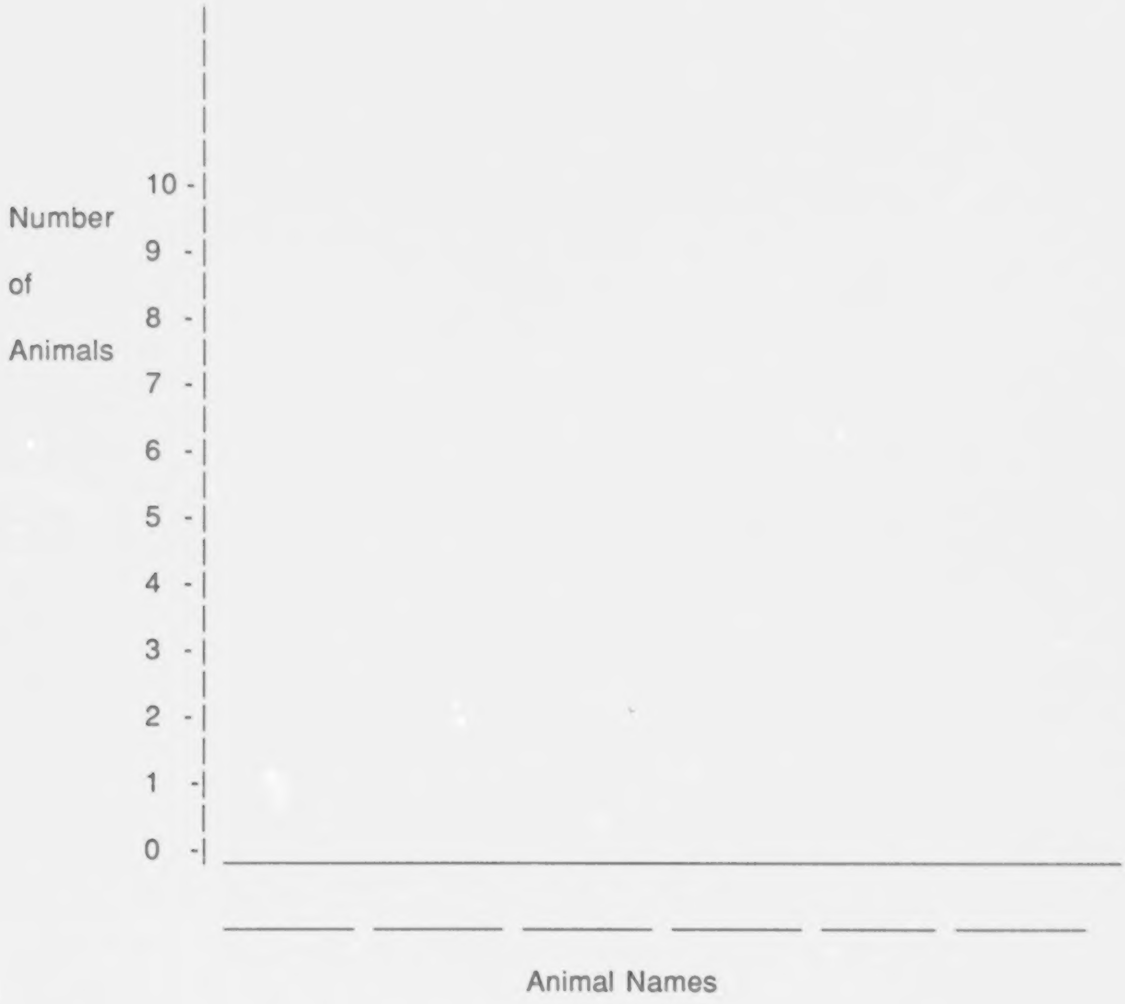
Habitat	Physical Description of Animal	Feeding Habitats

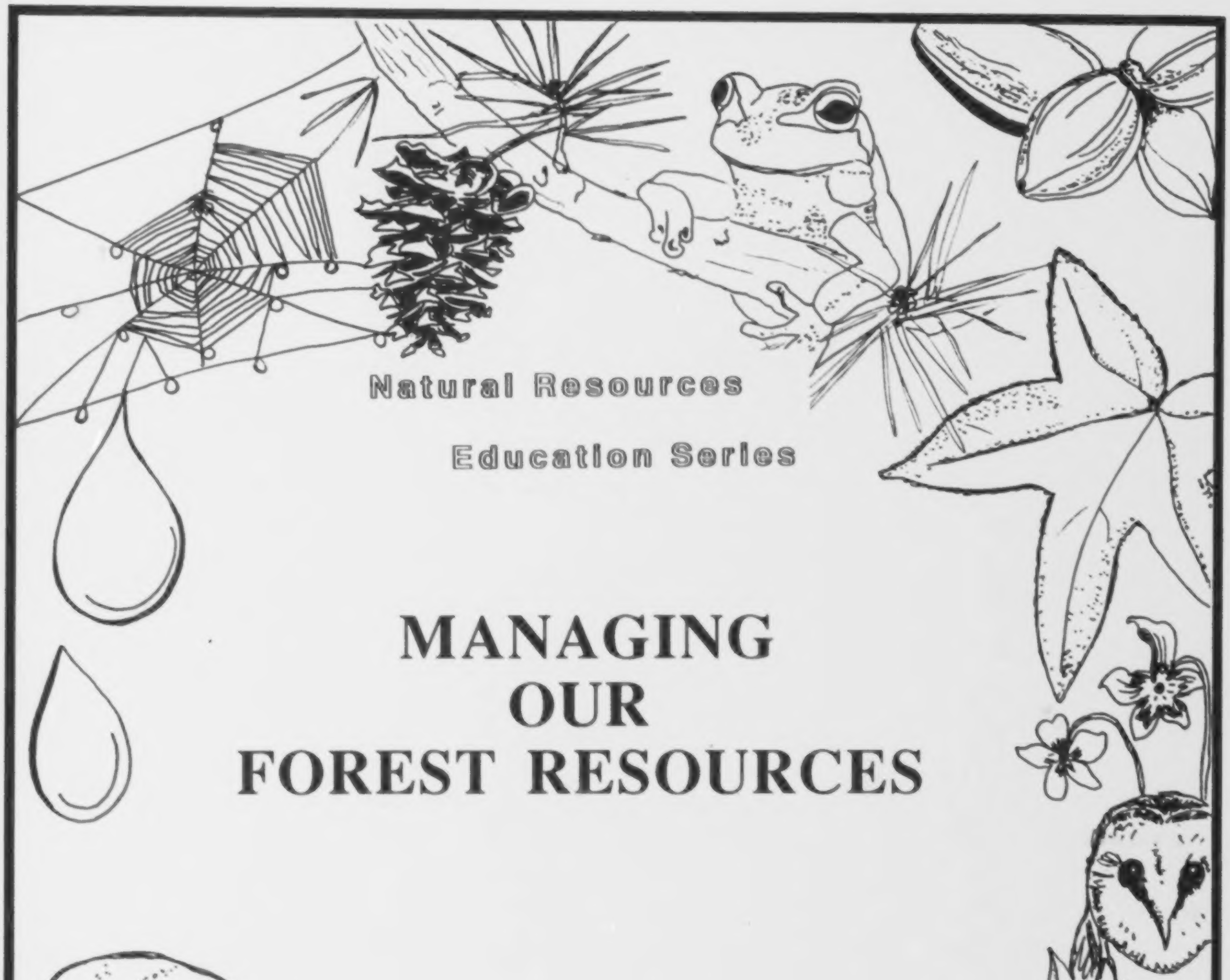
Animal:____

Habitat	Physical Description of Animal	Feeding Habitats

STUDENT HANDOUT 4

How Many Animals in Leaf Litter





Natural Resources

Education Series

MANAGING OUR FOREST RESOURCES

HOW DO WE TAKE CARE OF A FOREST

BEST COPY AVAILABLE

The writing, development and, production of the *NATURAL RESOURCES EDUCATION SERIES* is a joint project with collaboration of project directors Dennis W. Sunal, The University of Alabama, and Mary E. Haas, West Virginia University, and the U.S. Forest Service. Partial funding was provided by the U.S.D.A. Forest Service. The initial author and series editor was Dennis W. Sunal. Revision of individual modules was carried out with the help of Mary E. Haas, and Cynthia S. Sunal. Assistance in creating appropriate activities, proof reading, and creating art work by computer for the many editions was provided by Jon Berninzoni, Elwin Dickerson, Tracy Johnson, Jane McGinnis, and Sukhwindar Singh. Final editing assistance on the text and artwork was performed by Audrey Rule. William Kline, Jr. assisted in training the original trial teachers. Content reviewers were specialists in the various module topics at the U.S. Forest Service including Monongahela National Forest staff members, Theresa Anne, Randolph Harrison, Linton Wright, and Harry Mohoney, and Northeastern Forest Experiment Station, Timber and Watershed Laboratory staff Pamela Edwards, David Helvey, James Kochendorfer, and Clay Smith. Teachers in the Randolph County, West Virginia Schools who first taught the modules and made recommendations for revisions were: Sandra Arbogast, Sara Basil, Ann Deloach, Karen Hall, Richard Leitner, Elizabeth McDonald, Linda Moore, Sharon Moss, Pam Mullennex, Jeff Ranhart, Theresa Skidmore, Rachel Snavely, Charles Swecker, Nancy Taylor, Angela Vance and Rebecca Wallace.

The *NATURAL RESOURCES EDUCATION SERIES* is designed to supplement textbooks with active learning lessons for students in the primary and middle childhood grades (K-8). The series consists of Understanding Our natural Resources Teacher's Guide and 12 Modules including Appreciation of Natural Beauty, Soils and Plant Growth, The Water Cycle, Natural History of a Tree, Recipe for Tree Growth, Tree Growth and Environment, Forest Processes, Managing Our Forest Resources, Growth of a Forest, Interactions of Forest Plants and Animals, Natural Watersheds, and Managing Our Natural Resources.

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MANAGING OUR FOREST RESOURCES

MANAGING OUR FOREST RESOURCES

How Do We Take Care of a Forest?

BACKGROUND INFORMATION FOR TEACHERS

This module would be appropriate with science textbook and teacher prepared units relating to plants, plant growth, wildlife, animal habitats, environmental concerns and ecology. Some of the activities in this module require advance preparation. The module focuses on management of the forest community to maintain and replenish forest resources and esthetics which people have use for. The part of the management that deals primarily with the biological aspects of growing trees is called "silviculture." Social, economic and philosophical considerations are involved. The context of forest management always involves multiple, sometimes competing, purposes and ecological awareness. The purpose of this module is to give students an opportunity to compare a managed forest with a poorly managed one and to examine ways natural and artificial change in the plant community which relate to desired goals and resources.

Forests and forestry are often in the news and surface frequently as regional and national issues. Forest fire, gypsy moth plagues, endangered species, wilderness and hunting resources are a few of the topics covered. Forests and wood lots have been and are increasingly becoming ever more important resources for the 21st century. More and more the public is asking for information and questioning practices.

Silviculture has been practiced for hundreds of years. Forests are always growing and changing. They can be one or more of the following, new, static, growing, old, changing or dying. Forest managers attempt to imitate nature by creating conditions that at times occur naturally in the forest. Some natural events cause large areas of new growth to occur because many of the trees become damaged or dead. Severe winds as in a tornado, a forest fire, or widespread infestation of insects or disease create open spaces and growth in a tree stand or large region. When new growth starts in these areas the trees will be of similar age. This regrowth is called an "even-aged" forest. Other natural conditions create small spaces which produces individual tree replacement. Events such an individual tree dying due to disease, a lightening strike or a treefall due to wind provides small open spaces for young trees to grow in the midst of older, mature trees. This produces an "uneven-aged" forest. Trees of many different ages are found in these forests.

Over time, forests will take on a different appearance due to differences in naturally occurring conditions. Different trees and bushes produce food and shelter for different birds, insects, reptiles and mammals. Even-aged and uneven-aged forests will produce different plant and animal communities. Because of the need for more light, berry bushes, oak, hickory, black cherry and pine grow best in even-aged forests. These forests have only a few levels of tree branches and few variations in foliage densities and, thus, offer few types wildlife habitats at the same time. As the forest grows, different, successive habitats become available allowing new types of wildlife to flourish. On the other hand, maple and beech trees grow well in shaded small spaces of a mature uneven-aged forest. Many different size trees are available in uneven-aged forests. These forests have many branch levels and foliage densities offering different wildlife habitats at the same time. The diversity of wildlife is greater most of the time.

The two types of forests found naturally lead to two basic management styles. Even-aged management follows a growth and harvest cycle similar to those practiced in harvesting some agricultural crops. At regular intervals a fraction of the forest is harvested with most of the trees removed. Regeneration begins at that point from stumps, roots, plantings or seeding. This produces an even-aged forest. Uneven-aged management produces a continuous growth and harvest. Individual trees or small groups of trees are selected for cutting throughout the region at intervals of between 5 to 20 years. This type of harvesting creates a continuously changing forest due to the removal of specific types of trees during a harvest. New trees grow in the small openings under the shade of the older trees producing uneven-aged forest with small, medium and large trees side by side.

Other management practices include using chemicals and fertilizing. Hormonal and/or poisonous chemicals are used both to reduce the effort required in releasing seeds and to increase the probability of sprouting. These chemicals may be applied to individual trees, in an area, or sprayed from an aircraft. Fertilizing helps increase wood yields of forests through 1)remedying nutrient deficiencies, 2) increasing wood growth, 3) stimulating seed production, 4) improving tree or forest appearance, and 5) increasing production of plants valuable as forage for animals.

Some "micro"nutrients, those required in very small amounts, are important to forest health and production. These are copper, zinc, and boron. "Macro"nutrients,

needed in large amounts, important to forest health and production are nitrogen, calcium, phosphorous, and potassium.

Management of even-aged and uneven-aged forests is accomplished through three basic silvicultural approaches. One approach is by altering the existing forest community to provide space for reproduction of desired trees. Another is changing the surface of the soil to provide the optimal conditions for the growth of the forest. Lastly, management can occur by attending to the quality and type of seed provided as a seed source for the new population of trees.

The three basic management approaches employ a number of specific practices. These silvicultural practices encompass the methods used to directly control the plant population or change the physical environment. Six of these practices are described below.

> *Release cuttings* refer to the removal of undesired species and poorly formed individuals of a desirable species.
>
> *Stand improvement cutting* involves leaving large, well formed older individuals which normally produce many seeds. This is done when a stand is removed to encourage quick replacement of cut trees with quality seed types.
>
> *Sanitation cut* refers to the practice of cutting and sometimes burning disease-susceptible intermediate-aged trees to reduce chances of an epidemic.
>
> *Salvage operations* involve removal of valuable material from stands which might otherwise decay on the forest floor. Generally , this involves dead or dying trees with little long term ecological impact on the community.
>
> *Thinning* is accomplished by removal of individual trees so that individual trees in a stand will grow in the most socially valuable manner.
>
> *Pruning* is the removal of parts of trees in a stand to alter its form rather than its genetic or population characteristics.

OBJECTIVES: Choose those appropriate for your students.

-Name some products from the forest people use in their daily lives.

-Describe the forest as a manageable natural resource. Identify the process as silviculture.

-Describe purposes or goals in managing a forest.

-Compare managed forests with ones that are natural (unmanaged) or poorly managed. Identify a well managed area and contrast it to a poorly managed area.

-Identify general management approaches by which forests and tree stands are renewed or established.

-Demonstrate the use of mapping in planning for silvicultural management.

-Examine ways that foresters manipulate the forest to obtain desired results and illustrate a forester's responsibility in managing a forest.

-Identify silvicultural management practices, i.e., block cut, clear cut, selection cut, thinning, spacing.

-Identify appropriate silvicultural management practices for changing timber quality and quantity for specific purposes.

EXPLORATION PHASE

TO THE TEACHER:

The initial phase of *Exploration* involves interactive activities using observation, classification and other science process skills to help students, on their own, to discover basic concepts and relationships in forest management. The teacher should use this time to organize groups allow students to observe interactions and encourage students to investigate possibilities themselves. Students should be asking questions, gathering first hand information, and making connections to their previous experience in and out of school. Ideally the student should be confronted with a problem or event which cannot be explained by past knowledge.

EARLY CHILDHOOD ACTIVITIES

Materials: for each group

- 6-10 pieces of unprocessed natural wood (eg. cross sections, length of limb, pieces of bark, twig)
- processed wood objects (eg. wooden spoons, clothes pins, decorative carving, wood flooring, chair, small table, paper, pressed board, scrap pieces of wood from lumber yard or home wood shop)
- art supplies and paper

Involve the students in the following activities:

1. Allow students to see and handle samples of processed wood and natural wood. Ask students to make observations and if possible think of ways the pieces could be grouped.

2. After allowing time for handling and observing , ask the class a)"What is the same and what is different about the pieces of wood?" Answers should be similar to these: "some pieces are logs, some are boards, some look like they were just cut from a tree; others look like they came from a lumberyard/store." b) "What happened to this piece (holding a processed piece up for all to see) of wood?" Possible answers might include, "that piece came from a lumber store; that piece

was sawed; that piece could be used to build a house." c) "How did it get this way?" Possible answers include, "people cut it like this; it was sanded like this."

3. Explain to the students that some pieces are processed and manufactured. Point to, or hold up, the processed pieces. Explain that some pieces are unprocessed - hold up, or point to, the logs and fresh cut wood. Ask the class if the unprocessed wood is as usable as the processed wood. Why or why not?

4. *Optional: During a cut and paste art project, purposefully run out of paper. As your students become aware of the problem (they should bring it to your attention not you to theirs) ask them to propose a solution. Be ready to respond to their solutions with comments indicating a lack of availability of more paper. List their solutions and draw a flow chart similar to the way that paper reaches their school. Discuss with the students how paper gets to the school for their use. Include ;*

trees in forest --> cut trees --> haul to saw mill --> processing into chips --> ship to manufacturing plant --> soaking in water --> rolling and pressing -->paper is cut and packaged --> ship to stores --> purchase paper and take to schools.

MIDDLE CHILDHOOD ACTIVITIES

Materials: for the class

- 3 pine or spruce maple or other tree seedlings in pots 20 to 50 cm. in height -- a bushy one, a lanky one, and a symmetrical one. These may be obtained from outdoors in a wooded area. You could substitute marigold, coleus or other plant seedlings. These seedlings may be planted in class. As they grow, a) pinch off the growing ends of one to make one bushier, b) let another grow quickly in a dark area -- it should be lankier and c) pinch the growing ends of the third so that it is symmetrical. Several sets of 3 each can be grown so that students will later be able to work in small groups with a set.
- pruning shears or scissors
- Student Handout 1
- 30 cm. metric rulers
- drawing materials

Involve the students in the following activities:

1. Show the students all three specimens; bushy, lanky and symmetrical. Ask the students to fill out the matrix in Student Handout 1 as shown below in Figure 1. If done with the whole class, put a tree at each of three stations around the room. If working in groups, pass out a set to each.

2. After the students complete the matrix, ask the students to draw a projected mature plant from what they observe.

Figure 1
Comparison of Seedlings

	Seedling 1	Seedling 2	Seedling 3
Overall Shape			
Trunk shape			
Number of Branches			
Density of Foliage			
Color			
New growth			
Height			
Width			
Other Observations			

3. Ask the students questions to confront their way of thinking about growth. Correct answers are not necessary at this point. "How did the get this way?" "How could one change the growth patterns of these seedlings" "What might we do?" "What could we add or detract from the environment to help?"

TO THE TEACHER:

Pruning is the cutting away of plant parts such as branches, shoots, buds, or roots. Pruning helps plants recover from the shock of being moved. It controls the shape and beauty of ornamental plants. Pruning also helps improve the quantity and quality of fruit (and seeds) produced by trees.

Transplanted trees and shrubs are pruned to prevent water loss through the leaves. Usually about a third of the leaf-producing area is removed. Whole branches may be removed or the top third of each branch may be cut.

Weak stems are removed from shrubs at ground level. Diseased and broken branches should also be removed. People prune shrubs that flower early in the spring such as lilacs, just after they flower. Shrubs that flower in the summer like hybrid tea roses are pruned in spring. Gardeners shear hedges periodically to encourage dense and compact growth and to maintain a desired shape. Old trees usually are pruned to increase vigor, wood and seed production.

4. Discuss pruning with students. Show them a pair of pruning shears. Ask students to draw the three shapes represented by the seedlings -- bushy, lanky, and symmetrical. "Where would you prune to help each seedling achieve maximum health and stature?" Place a small X on each area you would cut. Ask students to share answers. Direct the students to demonstrate pruning with the 2 seedlings which are asymmetrical by using shears or through pinching off growth.

INVENTING THE IDEA PHASE

TO THE TEACHER:

During this *Invention Phase* of the learning cycle the teacher will play a more directive role. Refer to student notes and drawings, background information etc. The teacher may use inquiry techniques to reinforce *Exploration* activities or simply demonstrate and explain some of the ideas involved in silviculture. Students who were not able to answer the questions, problems or make sense of the events given in the *Exploration* should be led to an appropriate understanding at this time.

EARLY CHILDHOOD ACTIVITIES

Materials: for the class

- transparencies of Figure 2 and 3, "-Managed and Unmanaged Stands of Trees", or Student Handouts 2 and 3 for each group
- *drawing materials for making individual maps of a woods*

Involve the students in the following activities:

1. Distribute to students or show a transparency of Figure 2, *a managed stand of trees* and if needed Figure 3, *a poorly managed or unmanaged stand of trees*. Ask them to observe and describe the stand of trees. You may want the students to write or draw their responses as a data recording activity. Ask the students or groups to discuss their observations.

2. Following a discussion of the stand of trees, indicate or point out the poorly developed and the good or desirable aspects of the stand. These characteristics should include straightness of the tree trunks, number of branches, diameter of tree trunk, height of the trees, amount of sunshine possible through the canopy and the potential for adequate moisture to reach the ground near the trees. Ask the class why these characteristics may be important in the management of a forest and the potential use of these trees for aesthetic/recreational purposes and manufacturing wood products. Examples include a) straight trees with few branches, as usually seen in even-aged forests are valuable for lumber in constructing houses and b) trees with many branches and not especially straight would allow for a greater diversity of wildlife. Discuss with the students which trees they might remove to make the stand/wood near the school more desirable for either purpose. Make sure to get the class to justify their suggestions with references to criteria mentioned previously. Have them draw what they think the stand will look like afterwards.

Figure 2
Forest Stand Number 1 (A Managed Forest)

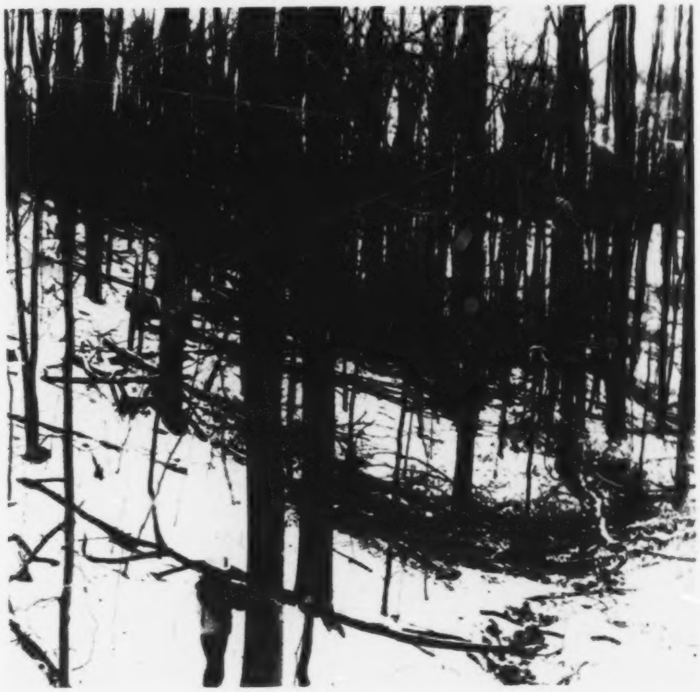
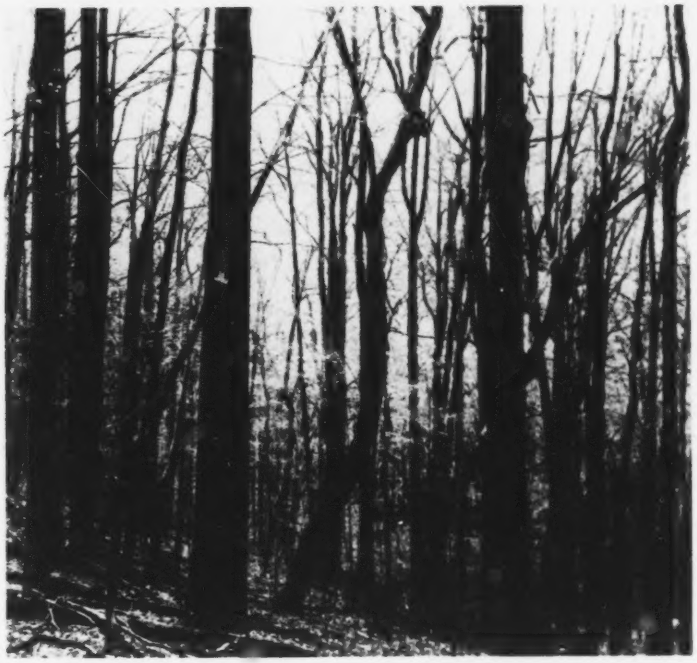


Figure 3
Forest Stand Number 2 (An Unmanaged Forest)



2. *Optional: Take students outside to a nearby woods or stand of trees and ask them to compare it to Stands in Figure 2 and 3. Ask questions to focus students on comparing stand characteristics. "How does it compare to the things (characteristics) we discussed in a managed stand of trees?*

   A. *Walk through the stand (3 or more trees) if possible and map the trees in the stand the way they are now. Note unusually shaped trees and heights of trees. Provide the students with a sheet of paper with the school building and major features already drawn in. Have the students draw the location of each tree in the stand. Different colors could indicate different heights (red = tall, blue = short). Very young students might draw each tree from a side view.*

   B. *Allow the students discuss and show their maps. The teacher should also map the stand and discuss his/her map after the students' presentations.*

   C. *Ask the class to think about things that could be done to change, manage for a specific purpose, the woods or stand they are observing. Ask the class what characteristics they observe in this stand may be important to manage for the potential use of these trees for (1) aesthetic/recreational purposes and (2) manufacturing wood products.*

3. For closure, discuss with the students the definitions of the following concepts;

   - forests can grow naturally or be managed for a purpose
   - purposes may include natural beauty, human need for natural resources (eg. processed and manufactured wood products), recreation, abundant wildlife and others.
   - managed and unmanaged forests look different and have different characteristics.
   - forest management creates conditions for some purposes more effectively.
   - many products people use come from the forest.

MIDDLE CHILDHOOD ACTIVITIES

Materials: for the class or each group

- transparencies of Figure 2 and 3, above, "-Managed and Unmanaged Stands of Trees", or Student Handouts 2 and 3 for each group (others can be used such as slides of a forest or a set of pictures of trees in forests brought in by students)
- notebooks
- *plastic flats from greenhouse (1 for each group)*
- *potting soil*
- *rotenone - growth hormone*
- *pruning shears*
- *sprigs of shrubs: Euonymous, privet, forsythia from yards*
- *house plant vines: jew, philodendron*

Involve the students in the following activities:

1. Show transparencies or distribute Student Handouts 2 and 3 to the students of, Figure 2, *a managed stand of trees* and, Figure 3, *a poorly managed or unmanaged stand of trees*. Ask them to observe and describe the stand of trees. The students should write or draw their responses as a data recording activity in a notebook. Ask students to respond to the following questions using their recent observations in their notebooks. Write the questions on the board.

   - What tree characteristics do you see in these pictures that represent good management of the forests for a specific purpose?
   - What characteristics do you observe in this stand that may be important to manage for the potential use of these trees for (a) aesthetic purposes b) diversity of wildlife, (c) manufacturing lumber for framing in houses and d) you specify one purpose.
   - What would a forester need to do to maintain such forests?
   - What (silvicultural) practices might a forester incorporate to help produce the best possible forest for a specific purpose?

   At this point students might project possibilities such as:
   - fertilizing
   - good seeds
   - soil management
   - adequate water
   - removing diseased trees
   - insect management
   - weeding
   - providing adequate growth space
   - or others, see Background section in this module.

2. Further questions to be considered are:
   - How do we get the most select and hardiest trees?
   - Do they always come from seeds or seeds produced from forest trees?

TO THE TEACHER:

Tree reproduction can originate vegetatively in many hardwoods and a very few conifers and by seed in nearly all tree species. Vegetative sprouts may arise from buds developing in callous tissue formed by the cambium in cut stumps. Vegetative reproduction can also be carried out in some tree species by means of cuttings. In this technique, portions of the parent tree are cut off and planted (sometimes after artificial hormone treatment to incite root development).

Seeds are the beginning of most natural stands. After going through a juvenile period, trees produce seeds. Tree characteristics of age to begin seedbearing, period of seed crops, amount of seed, and exact characteristics of the seed with reference to seed viability over time, resistance to environmental extremes, dispersal mechanisms and germination requirements vary greatly with species and environment.

Seed is usually collected during years of abundant production. Collection procedures vary. In one process parent trees of high quality are selected in stands reserved for seed production. They are usually harvested of their cones or seeds by skilled forestry employees using special techniques.

Seed is sown in prepared beds, and disease control programs are initiated. Nursery sites are carefully selected for correct soil and climate. Time in a nursery may vary from 1-6 years. Roots often are pruned to promote a compact root system. Seedlings often are transplanted to an area of wider spacing after a year or two. Later, they are transplanted to the field/forest.

3. Optional: Propagating Plants over a few weeks

Divide class into groups. Provide each group with one pair of shears, one knife, one plant flat, soil, one cup with rotenone, and plenty of sprigs from shrubs and house plant vines.

Ask the students to distinguish between woody and nonwoody (herbaceous) species. Then, the teacher should demonstrate to the class how to cut each piece, then dip it in rotenone to produce callous tissue and prevent rotting. Additional directions are found in the rotenone package. Then place a row 4-6 cuttings of woody and a row of herbaceous cuttings in soil in a flat.

Water the plantings and place them in sunlit area. Continue to water and record new green growth. After a few weeks ask students how else plants might be produced? How can we manage the final characteristics of the plant using silvicultural practices?

7. For closure, discuss with the students the definitions of the following concepts;

- forests can grow naturally or be managed for a purpose.
- the forest is a natural resource.
- the process of forest management is termed silviculture.

- purposes for management may include natural beauty, human need for natural resources (eg. processed and manufactured wood products), recreation, abundant wildlife and others.
- managed and unmanaged forests look different and have different characteristics.
- forest management creates conditions for some purposes more effectively.
- there are 3 general management approaches by which forests and tree stands are renewed or established. One approach is by altering the existing forest community to provide space for reproduction of desired trees. Another is changing the surface of the soil to provide the optimal conditions for the growth of the forest. Lastly, management can occur by attending to the quality and type of seed provided as a seed source for the new population of trees.
- there are a number of silvicultural management practices, (i.e., block cut, clear cut, selection cut, thinning, spacing) each important for changing timber quality and quantity for specific purposes.

EXPANDING THE IDEA PHASE

TO THE TEACHER:

In the final learning cycle phase, *Expansion*, the student must use and apply facts, concepts, and relationships concerning silviculture. Students should refer to cumulative information notes, fact sheets, etc. New contexts and different ways of looking at the ideas explained in the earlier part of the lesson should now be attempted. Following *Expanding The Idea*, the teacher should check student outcomes with a quiz; performance test, and/or discussion.

EARLY CHILDHOOD ACTIVITIES

Materials: for the class
- tree seedlings from local forestry agency or plant nursery
- tree seeds saved from last fall, picked off trees now, or obtained from a local forestry agency.
- brochures from your local forestry agency on the their activities.
- contact your local forestry agency and set a date for a guest speaker to visit your class.
- *drawing paper*
- *glue*
- *seeds and tree seedlings or pictures/posters of them*

Involve the students in the following:

1. Assign to students as homework the task of collecting pictures and names of things made from paper. List, count, and discuss the items the class mentions as paper products. After discussion ask: "Where are we going to continue to get trees to make these paper products?"
   A. Inform your students that one of the jobs of the U.S. Forest Service, individual farmers and owners of wood lots is to maintain forest resources for manufacturing of goods and products with paper being a major product.
   B. Ask the class if they have any suggestions as to how the Forest Service might accomplish this. Discuss their suggestions. Introduce and define the idea of reforestation -- the planting of new trees on land once forested but now left barren.
   C. Using pictures, posters, or preferably real tree seeds and seedlings conduct a discussion of how foresters may seed a forest. Also, discuss the naturally occurring reforestation process -- the dropping and scattering of tree seeds by animals, birds, and the wind.

2. Find and area around the school which would benefit from tree planting and have students scatter tree seeds or plant tree seedlings. Stake off the area and visit the area with the class at regular intervals.

3. *Optional: Using glue and drawing or construction paper have the students construct a collage of what the ground will look like after artificial or managed (performed by people) seed dispersal over a barren area. Glue down actual seeds or seedlings (small twigs) or pictures of them.*

4. *Optional: Plant a tree seedling and keep records of its height and width throughout the year. Maintain a year long display of goods and products that may be traced back to the forest.*

5. Invite a forest ranger or forester from your local forestry agency or local Chamber of Commerce and ask them to describe and demonstrate some of their professional activities.

MIDDLE CHILDHOOD ACTIVITIES

Materials: for the class
- writing and drawing materials
- photographs of forests (may be provided by students)
- tree seedlings from local forestry agency or plant nursery
- tree seeds saved from last fall, picked off trees now, or obtained from a local forestry agency.
- brochures from your local forestry agency on the their activities.
- contact your local forestry agency and set a date for a guest speaker to visit your class.
- *drawing paper*
- *glue*
- *seeds and tree seedlings or pictures/posters of them*

Involve the students in the following activities:

1. Redesign a given area on the school grounds or in a nearby neighborhood so that principles of good forest management might be included. Students may use their family's photographs of an area, perhaps those they have taken near their home. Ask student groups to draw the area as it currently is on an overhead transparency. Then draw a transparency overlay which will show changes to be made in the area or draw a before picture and a picture showing changes planned on paper. Students should also describe in writing and present to the class the changes they make which represent good silvicultural practice.

2. *Optional: Plan an excursion to a local forest. Have the forester or forest ranger explain and demonstrate principles of good forest management. Students might be asked to draw a map and outline advisable practices of maintenance for a specific area. They could be asked to provide other suggestions and a rationale for development. The work can be evaluated by the forester.*

3. *Optional: Students should be made aware of volunteer planting activities seedlings/transplanting in conjunction with forestry, Arbor Day or community or agricultural agencies.*

4. *Optional: Find and area around the school which would benefit from tree planting and have students scatter tree seeds or plant tree seedlings. Stake off the area and have them visit the area and report progress at regular intervals.*

5. Invite a forest ranger or forester from your local forestry agency or local Chamber of Commerce and ask them to describe and demonstrate some of their professional activities. They could be asked to evaluate work performed earlier in the module by the students. A panel should be formed to interview the forester on questions, concerns and current events in the newspapers concerning the use and misuse of our forests as a natural resource.

FINAL EVALUATION

The teacher may test students on terms or concepts gained as expressed in the module objectives and closure. The teacher may incorporate work and products not used in the lesson from the *Expanding The Idea* stage for the final evaluation. Students may be asked to form panels to discuss current concerns and events in the news relating the forest management, the forest as a natural resource or competing purposes for managing or not managing forests. Finally, a teacher may wish to utilize a written project or essay format of his/her own design covering the main ideas discussed during the module.

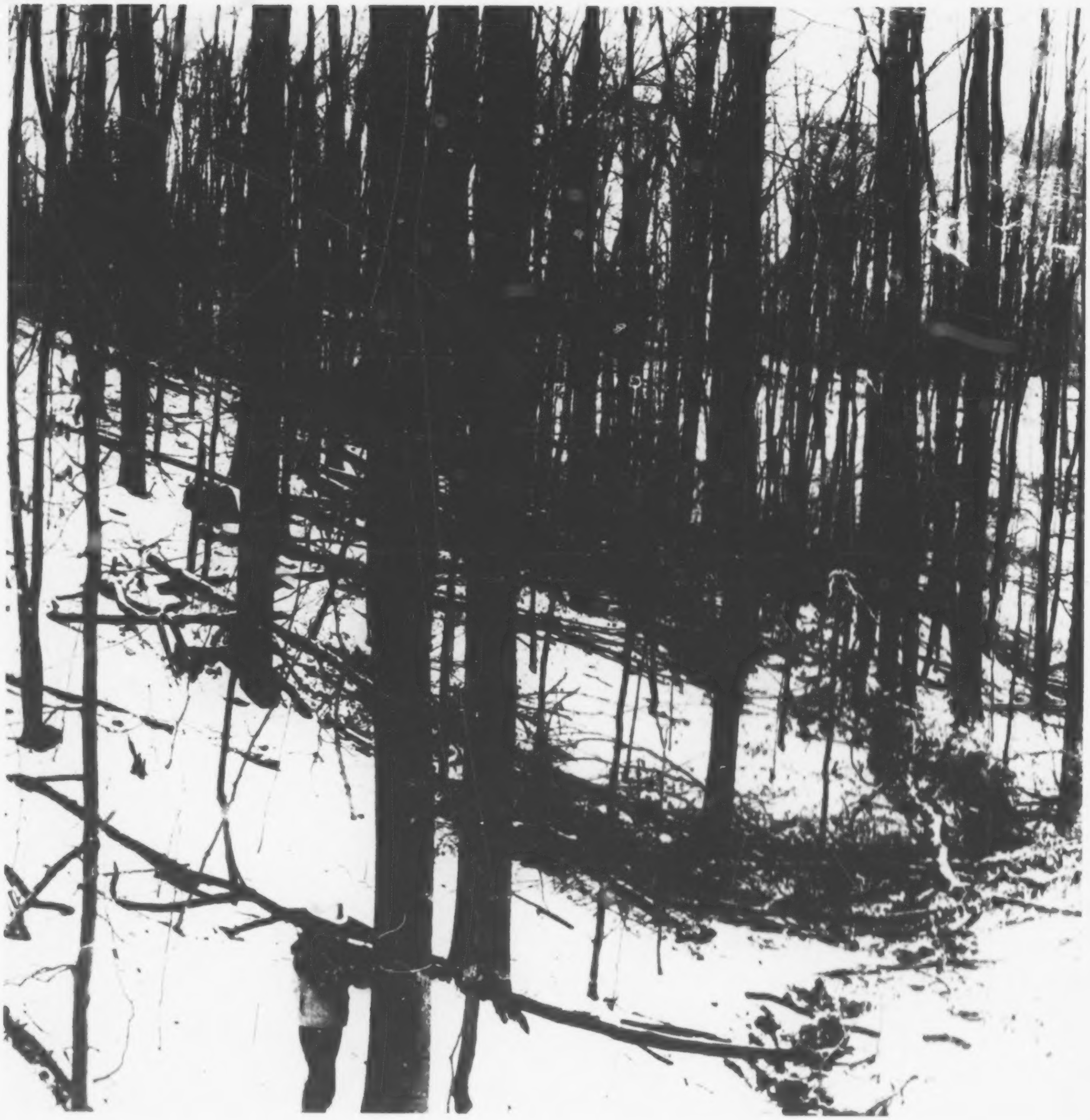
STUDENT HANDOUT 1

Comparison of Seedlings

	Seedling 1	Seedling 2	Seedling 3
Overall Shape			
Trunk shape			
Number of Branches			
Density of Foliage			
Color			
New growth			
Height			
Width			
Other Observations			

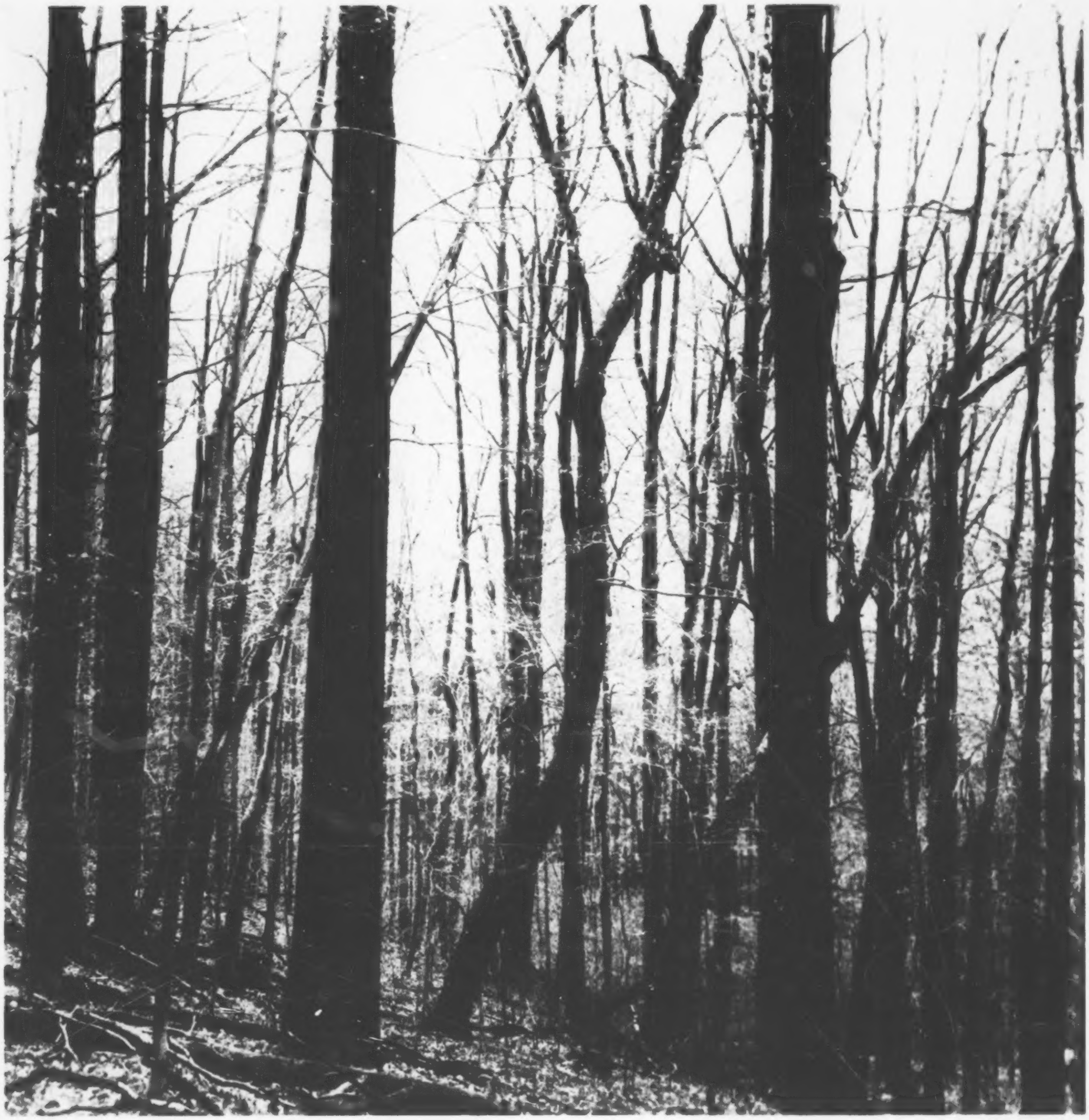
STUDENT HANDOUT 2

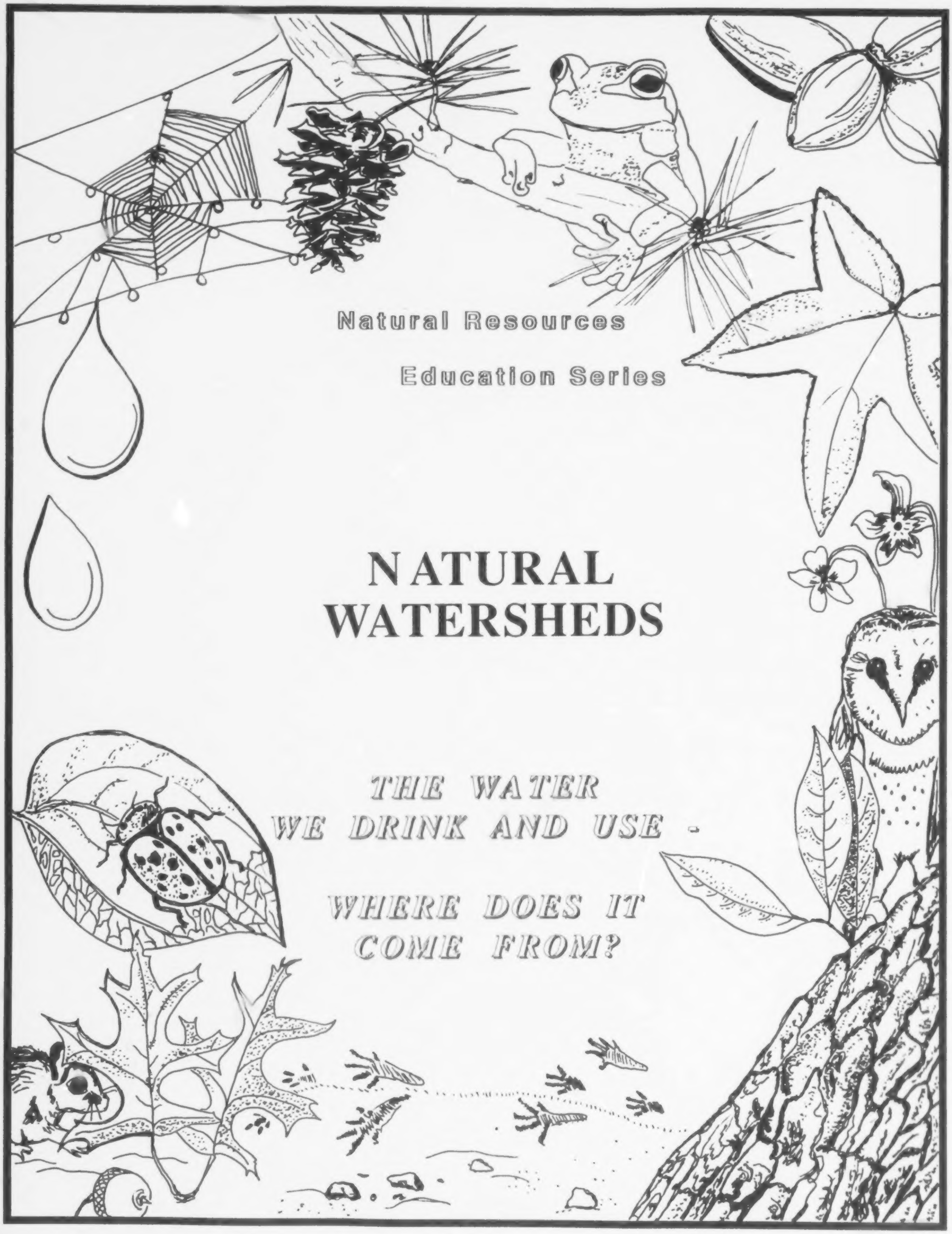
Forest Stand Number 1



STUDENT HANDOUT 3

Forest Stand Number 2





Natural Resources

Education Series

NATURAL WATERSHEDS

THE WATER WE DRINK AND USE -

WHERE DOES IT COME FROM?

BEST COPY AVAILABLE

The writing, development and, production of the *NATURAL RESOURCES EDUCATION SERIES* is a joint project with collaboration of project directors Dennis W. Sunal, The University of Alabama, Mary E. Haas, West Virginia University, and the U.S. Forest Service. Partial funding was provided by the U.S.D.A. Forest Service. The initial author and series editor was Dennis W. Sunal. Revision of individual modules was carried out with the help of Mary E. Haas, and Cynthia S. Sunal. Assistance in creating appropriate activities, proof reading, and creating art work by computer for the many editions was provided by Jon Berninzoni, Elwin Dickerson, Tracy Johnson, Jane McGinnis, and Sukhwindar Singh. Final editing assistance on the text and artwork was performed by Audrey Rule. William Kline, Jr. assisted in training the original trial teachers. Content reviewers were specialists in the various module topics at the U.S. Forest Service including Monongahela National Forest staff members, Theresa Anne, Randolph Harrison, Linton Wright, and Harry Mohoney, and Northeastern Forest Experiment Station, Timber and Watershed Laboratory staff Pamela Edwards, David Helvey, James Kochenderfer, and Clay Smith. Teachers in the Randolph County, West Virginia Schools who first taught the modules and made recommendations for revisions were: Sandra Arbogast, Sara Basil, Ann Deloach, Karen Hall, Richard Leitner, Elizabeth McDonald, Linda Moore, Sharon Moss, Pam Mullennex, Jeff Ranhart, Theresa Skidmore, Rachel Snavely, Charles Swecker, Nancy Taylor, Angela Vance and Rebecca Wallace.

The *NATURAL RESOURCES EDUCATION SERIES* is designed to supplement textbooks with active learning lessons for students in the primary and middle childhood grades (K-8). The series consists of Understanding Our natural Resources Teacher's Guide and 12 Modules including Appreciation of the Natural Beauty, Soils and Plant Growth, The Water Cycle, Tree Growth Rings and What They Tell Us, Recipe for Tree Growth, Tree Growth and Environment, Forest processes, Taking Care of Our Forests,, Growth of a Forest, Interactions of Forest Plants and Animals, Natural Watersheds, and Managing Our Natural Resources.

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NATURAL WATERSHEDS

NATURAL WATERSHEDS

THE WATER WE DRINK AND USE - WHERE DOES IT COME FROM?

BACKGROUND INFORMATION FOR TEACHERS

This module would be appropriate with chapters in existing science texts relating to water and water cycles, erosion, streams and lakes, weather, where plants and animals live, the changing earth, and the earth's resources. The activities within this module ideally require several days, but are flexible enough to be shortened or extended to fit the teacher's schedule. The teacher is advised to read over the activities carefully and plan accordingly.

A watershed is the area contributing water to a stream, river, or lake. As precipitation occurs, the resulting water obeys the laws of gravity and seeks the lowest possible level. To achieve this lowest possible level water will "runoff" in small streams on the surface of the surrounding land area towards a valley or gully bottom or any depression in the landscape. Water also moves as subsurface flow through cracks and pore spaces in the soil and bedrock toward lower elevations. Such ground water flow generally parallels the surface drainage pattern, but may be different, depending upon the nature of the underlying bedrock.

Management of a naturally occurring event may appear to be a contradictory concept. If an event occurs naturally then why attempt to influence it in any way? Watershed management may be misconstrued as a human attempt to control nature. The concept of watershed management is the scientific inquiry into the process of water runoff and the management of that runoff for various purpose. Some management goals are conservation of soil, flood control, and prevention of stream and river pollution.

All natural drinking water contains small quantities of dissolved mineral salts which contribute to the water's taste. When speaking of pure water or spring water it is taken for granted that the natural mixture of water and small amounts minerals exist in water.

The concept of water pollution refers to the undesirable foreign matter in a normally natural substance which decreases the quality of the water. Water quality may be defined as its fitness for beneficial uses. For example, good quality water is needed to support plant life, for drinking by people and animals, for the support of wholesome aquatic and marine life, and for irrigation of the land and for recreation. Non-living or inorganic compounds such as lead, mercury, or radioactive elements, and living or organic substances such as microorganisms and waste products are a few of the kinds of pollutants.

Forests cover approximately one-third of the total land area of the United States. Through these forested areas flows more than half the nation's streams. The chacteristics of a watershed directly impacts the natural water resources of an area. Water resource areas may vary in size from a small creek or pond to large lakes and rivers. Like other natural resources, this water can be managed properly. A forest exhibits considerable influence on the water reservoir through the water holding and transporting capabilities of its soil. The best forest soil for water storage is porous soil. This soil can be maintained through proper forest management. Hot fires, human traffic, heavy grazing, and improper cutting can result in destruction of the soil structure. By controlling these events the resultant erosion, increased sedimentation, and increased surface water runoff can be curtailed.

The objectives of watershed management are to obtain the desired quality and quantity of usable water for domestic, agricultural, and industrial uses from wells or rivers well at the same time maintaining fish and wildlife habitats and recreation opportunities.

OBJECTIVES: ***Choose those appropriate for your students:***

-Practice and develop observing and classifying skills.

-Identify and describe functions of watersheds.

-Identify and describe a watershed region.

-Examine some means of controlling runoff.

-Examine some of the consequences of uncontrolled runoff.

-Describe factors contributing to water pollution.

-Describe the impact pollution and acidic water has on the quality of flora and fauna.

-Foster an understanding of watershed management.

-Create awareness of aspects of a watershed manager's duties and responsibilities.

EXPLORATION PHASE

The initial phase of exploration involves interactive activities using observation and other science process skills to help students, on their own, discover basic concepts and relationships in watershed management. The teacher should use this time to organize groups, observe interactions and permit students to investigate possibilities themselves. Students should be asking questions, gathering first hand information, and making connections to their previous experience in and out of school. Ideally the student should be confronted with a problem or event which cannot be explained by past knowledge.

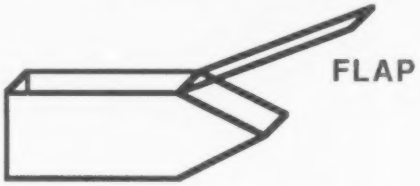
EARLY CHILDHOOD ACTIVITIES

Materials: per work station (three work stations in total)
- 6 Samples of grassy soil or piece of sod and exposed soil with no vegetation (10 cm x 20 cm or 4 in. x 8 in.)
- 2 half gallon (2 liter) milk or juice cartons with side cut off and hole in bottom (see below)
- 1 half gallon plastic or paper collection container for water
- 3 cm (1 in.), 10 cm (4 in.) and 20 cm (8 in.) long paper towel tubes or blocks - labeled A, B, C - to prop up one end of the milk carton to produce different slopes.
- 2 measuring cups - use a clear plastic cup or jar filled with water (see instructions below for how to make one)
- 1 felt pen for marking cups
- Observation and Recording Chart - Student Handout 1

TO THE TEACHER:

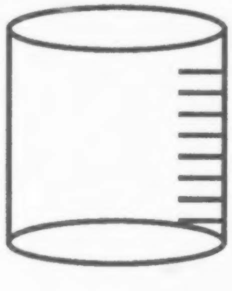
Prepare materials for three observation stations prior to introducing the concept. Set up stations as follows -

1. Cut six 1/2 gallon (2 liter) milk or juice cartons so that each has a flap as pictured:

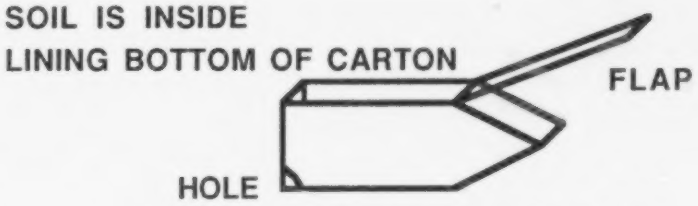


MILK CARTON WITH CUT FLAP

2. Have two measuring cups filled with clean water for each station. A clear plastic cup or jar with even spaced teacher made markings (8) on them will work fine. Put one half gallon containers at each station to collect the drained water.



3. At each station, place a piece of turf inside the milk container and the exposed soil inside the second container on what are now the bottom sides of the containers. Punch a hole in the bottom corner of each carton so that water that has run through the sod or exposed soil can be collected through the hole.



MILK CARTON WITH CUT FLAP

4. At each station, place one of the paper towel tubes or blocks. Put the tube or block under each station to change its slope.

5. Place an observation/recording form at each station. You may wish to provide Student Handout 1. Also, record the amount of water on the blackboard, Figure 1. Have students look at and measure the water (count the lines) in each cup and record the amount of water on Student Handout 1 and on the blackboard.

STATION	AMOUNT OF WATER IN MEASURING CUP	
Slope	Turf	Clay
A (3 cm)		
B (10 cm)		
C (20 cm)		

Figure 1
RECORD OF WATER RUNOFF

Involve the students in the following activities:

1. Short 10 - 15 minute field trip to school grounds. As a beginning activity for this module you may want to introduce your students to the central concept of watershed through an excursion to a watershed on the school grounds. (Look for an area that shows evidence of several small water sources converging into a larger central run-off, for example, gutters to a ditch.) A discussion by a guest lecturer or a visit to a managed watershed area in your local school district may also be used at the end of this module.

2. Ask students to describe the watershed example area shown to them. What happens to the water in this area during and after a rainstorm? Have a container of water ready for students to demonstrate their predicted description of water paths. Ask them to describe the cleanness of the water following the demonstration.

3. Return to the classroom for an activity investigating how differences in water clean-

ness or purity can come about. Ask some students to demonstrate the following at the prepared stations.

A. Using the "turfed milk" carton, place the 3 cm tube or block, labeled A, under the flap and gently pour the measured water onto the turf. Use a sprinkling can if one is available.

B. Allow the water to run off into the bottom of the milk container for about five minutes. Let the water to run into the hole cut in the bottom corner of the container and into a half gallon collection container now positioned at the hole. See Figure 2.

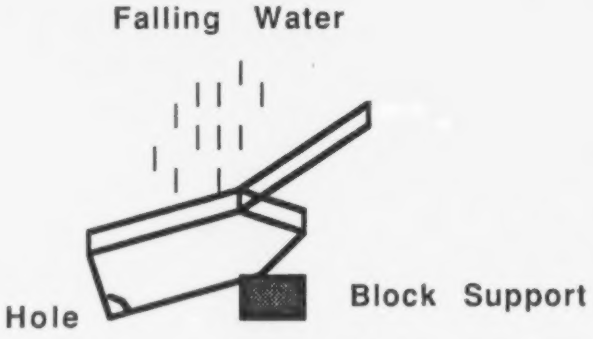


Figure 2
RUNOFF SET-UP

4. Show the class how to record their observations on the Student Handout 1. Students are going to pour only one cup of water on each soil type while at each station. They will pour the collected water runoff back into the same measuring cup used for pouring. Save the runoff water. Ask students to record the beginning and end amounts of water on Student Handout 1.

5. Ask students to discuss what occurred and why. What does water in the measuring cup look like? How much was collected? Also, have them describe the water quality and aspects which might make this water undrinkable.

Ask students in groups to investigate the following at the prepared stations.

6. Repeat the activity with turf and exposed soil at each station. Different stations will use a different tube A, B, and C (each represents a different slope). If possible, the students should be asked to perform the experiment themselves in 3 groups. One group per station, and report results to the whole class. The next best procedure would be to ask student volunteers to do this for the whole class as a demonstration at each station. Ask students to record all information on Student Handout 1.

7. Students in the three groups will share results by filling in the information on the blackboard and on their group sheets.

8. *Optional: What is polluted water?*

Materials: *for each group*
- *10 clear plastic glasses or pint (1/2 liter) glass containers*
- *water*
- *1 tablespoon each of salt, sugar, pepper, plastic bits, dirt, paint or tempera, ammonia, dish soap or detergent, plus other common household materials*
- *1 magnifying glass*
- *1 tablespoon*

Involve the students in the following activities:

A. *Divide the class into observation groups of 3 to 5 students each.*

B. *Provide each group with 10 containers for observations.*

C. *Fill the containers approximately 3/4 full of tap water.*

D. *For each group/container provide:*
   - *1 tablespoon of salt*
   - *1 tablespoon of sugar*
   - *1 tablespoon of pepper*
   - *1 tablespoon of plastic bits*
   - *1 tablespoon of dirt*
   - *1 tablespoon of paint (any color)*
   - *1 tablespoon of ammonia*
   - *1 tablespoon of detergent*
   - *1 tablespoon each of other household materials*

   Before adding these ingredients to the water ask, "Is there a difference in the water anyone has?" (expect "No" as an answer).

E. *Have students add the materials, "pollutants," to the water one by one. Put one material in each container. You may provide labels identifying each material to be attached to the container with tape. After each addition stir, then observe what is in the jar. Possible prompting or guiding questions for the observations are:*

   - *What happened to the water?*
   - *What happened to the materials you put in the water?*
   - *Why can't you see some of the materials you put in?*

F. *Save two sets of the containers to use later in the Expanding The Idea Phase of this activity. Cover the containers to limit evaporation.*

MIDDLE CHILDHOOD ACTIVITIES

TO THE TEACHER:

Set the stage for this activity by reviewing what will take place in the allotted time. *Exploration* will begin with discussion through inquiry type questions leading to collecting and interpreting data and making inferences on watershed design and water quality.

This *Exploration* may be a field activity or can simulated through data provided at the end of the module. If you are simulating the activity, make transparencies of Figures 3 and 4.

Students will be asked to recall, brainstorm ideas, and reflect on earlier observations made in previous science activities. Grouping will work best with 3 to 4 students in a group.

Materials: for each group
- 500 ml (1 pint) each of 3 water samples - student collected or teacher supplied from different sources (one should be tap water)
- 1 square sheet of plastic - 1/2 meter by 1/2 meter (1 1/2 ft. by 1 1/2 ft.)
- 3 filter paper - use coffee filters or paper towels
- 6 straws
- 2 beakers or plastic glasses
- 1 funnels - to aid in filtration
- 1 microscope
- pH paper or hydrion paper
- 1 medicine dropper
- rocks

Involve the students in the following activities:

1. Begin by asking the students to list on a sheet of paper all the types of pollution with which they are familiar. Separate the students into groups, then ask each group to share their personal lists with each other. Ask groups to share their lists with the whole class. Write a list on the board. Ask students to classify pollutants as land, air, or water pollutants.

2. Ask each group to brainstorm a second list of only water pollutants. In addition to the pollutants students should list where polluted water is usually found. After sharing this second list, ask, "What do these pollutants look like?" "Can you identify them in water?" "What type of pollutants can you find in water?"

3. Provide the following information to students. These are found also on Student Handout 2 and 3.

   A. Types of impurities in water:
      1. Suspended Particles - These are particles with diameters above 1 micron (.001 millimeter) and large enough to absorb light. They make the water

look cloudy or murky (e.g. dirt or other solid materials mixed in water). The particles can be quite large.

2. Colloidal Particles - These are very small particles smaller than 1 micron. The settling rate is insignificant. The particles pass through holes of most filter media, therefore they cannot be removed from water by settling or ordinary filtration. They do make water cloudy when viewed at right angles to a beam of light. (e.g.. a few drops of milk, ink or coloring in a glass of water)

3. Dissolved Matter - These particles do not settle out, cannot be filtered and do not make water cloudy even when viewed at right angles to a beam of light. The liquid is transparent with a clear to dark color range. Particles are molecular in size. If they bear an electric charge the particles are called ions (e.g. salt water, sugar water, tap water with dissolved minerals). Evaporation of the water will leave a residue.

B. *What is "pH"?*

pH can be explained as being similar to a yardstick. It is a method of measuring too much of one thing or too much of another thing. You may discuss acidity and alkalinity referring to the pH chart. Ask students which they would want to put their fingers in battery acid, household lye, a base (e.g. Liquid Drano), or milk? Both acids and bases can burn your skin. Do not try this.

Another analogy clarifying the term "neutral" would be a car without brakes resting high on the tip of a mountain. If we put the car in forward, "Boom! Down the mountain the car would go!" If we put the car in reverse, "Boom! Down the mountain the car would go!" But in neutral, nothing happens chemically and the car remains the same.

Different plants respond differently to pH levels in the soil. For example, azaleas and rhododendron grow well in an slightly acid soil. Other plants grow well at at less acid pH levels.

Table 1
pH Chart: Alkaline to Acid

Alkaline (Basic)	---	Ammonia, Lye, Bleach, Baking Soda, Tums, Pepto Bismol
Neutral	---	Milk, Corn, Meat
Weak Acid	---	Cream of Tarter, Vitamin C Tablets
Acid	---	Vinegar, Orange Juice, Concentrated Lemon Juice, Coca Cola
Strong Acid	---	Battery Acid

4. Optional: Acid/Base Familiarization Activity

Materials: for each group or for the class if done in stations

- *6 clear plastic glasses*
- *2 tablespoons of the following: household ammonia, milk, grapefruit juice, vinegar, concentrated lemon juice, cream of tartar mixed in water, cooking oil, plus other kitchen or household liquids (Do not use highly toxic or dangerous liquids).*
- *spoon*
- *phenolthalein or pH paper or hydrion paper*

A. Put a small amount of one the household liquids listed above into a plastic cup and label it. Do this for each of the liquids you want to test.

Be prepared for students to react to the strong smell of the ammonia. Warn them not to inhale it. Pour the ammonia in a well-ventilated place. Students should wear safety glasses when pouring the ammonia. Water should be available for washing should there be an accident with the ammonia or any of the other liquids.

B. Test the solutions to determine their pH. Use phenolthalein or pH paper (directions will be given on the container). Record each solution and its pH on chart paper.

C. Discuss and compare results with the whole class. Pass out Student Handout 3 and ask students to write in their liquids in the proper location.

4. Students should now be asked to investigate and collect data. Provide students with Student Handout 2. Using the water sample provided complete a chart like the one below, Figure 3. To complete the activity, the students should first make observations of the water at their own desks. They then could be directed to stations set up around the room.

Station 1	Acid/Base:	Test the pH of your sample (see Student Handout 3).
Station 2	Microscopic Organisms:	Observe your sample on a microscope slide for microorganisms by putting a drop of sample on a slide and looking at it under the microscope.
Station 3	Particles:	Students should use filter paper and a funnel to filter a small measured portion (e.g.. 50 ml) of each sample into a beaker or glass. What residues do you find? If time permits, look at residues under the microscope.

	Sample 1	Sample 2	Sample 3
Appearance and Color	cloudy white	clear brownish	transparent yellowish
Microscopic Organisms	yes	no	no
Odor	bad	none	sulphur
Acid/Base pH	acid pH = 4	neutral pH = 7	acid pH = 6
Particles Residue	suspended white powder	dissolved brown residue	dissolved orange residue

Figure 3. Water Sample Inspection Results

4. You should continue with additional inquiry questions. These questions refer to a fresh water lake. Similar questions may be asked about land plants. Select those most appropriate for your unit. Do not provide answers at this time. Allow the students to discuss and suggest ways to find answers.

   A. "Are there pollutants in the water you cannot see?"
   Find out by doing the following:
      (1) Place 1 square 1/2 meter by 1/2 meter (1 l/2 ft by 1 1/2 ft) black plastic near a window or radiator.
      (2) Place filter paper on top.
      (3) Have students label filter paper and place drops of water from 3 different samples on paper using straws.
      (4) After water evaporates, check residues. "What type of dissolved water material (a possible pollutant) do you see here?" Check the filter paper and the plastic beneath each spot. Remember clear water is not necessarily safe to drink.

   B. How does reducing the amount of light reaching a "water plant" affect the plant? (The amount of food it produces by photosynthesis can be diminished. Suspended particles cut down on the amount of light passing through water.)

C. What effect can the suspended particles in water have on a plant? (They can clog the stomata, hindering the exchange of gases).

D. How can the suspended particles of water pollutants affect fish? (They can clog the fish's gills).

E. What can happen to an animal that swallows polluted water? (Some pollutants, like oil or heavy metals (lead compounds) may be poisonous when ingested by fish, or they may be poisonous to other fish and other animals that eat them).

F. What can happen to aquatic animals when there are too few plants? (Lack of plant life can break the food chain, causing starvation among animals).

G. What can happen to the balance of the ecosystem if too many minerals, dissolved matter, are added to the water? (Plants can grow too fast, too large, and in too great a quantity which might result in a pileup of decaying plants on the bottom. Bacteria working on decomposing these plants may use up so much oxygen that there is not a sufficient supply for the animals, which may consequently suffocate.

INVENTING THE IDEA PHASE

TO THE TEACHER:

During this phase of the learning cycle, the teacher will play a more directive role. At this time the teacher may wish to refer to notes, background information, etc. The teacher may use inquiry techniques to reinforce exploration activities or simply demonstrate and explain some of the ideas involved in watershed conditions and water quality. Students who were not able to answer the problems or events given in the *Exploration Phase* should be led to an appropriate response at this time.

EARLY CHILDHOOD ACTIVITIES

Involve the students in the following activities:

1. Ask students to compare the results from the three stations. Discuss the results of the exploration with your class. What happened? What patterns did you find? Why did this happen? Lead them to the conclusion that soil type and soil slope are two things which affect water runoff and water quality.

2. Take the class for a walking field trip to a nearby stream or river. If not near enough to a stream or river use enclosed poster/picture. See Figures 3 to 6. Discuss the things which affect water runoff in these situations. Draw students' attention to the

slope of the land surrounding the stream or river. Ask: "Would all of the precipitation run into the stream or river?" "Why or Why not?" Discuss.

3. *Optional: The following activities must be timed for a rainy day or shower.*

   A. *Does all rain reach the ground? Have the students perform the activity described below. You may wish to use Student Handout 4.*

   Place two 5-pound coffee cans or other large containers out in the open before a rain storm. Place three identical containers under a tree before the same storm. Spread these containers around under the tree. After the storm has ended measure the depth of water in each container with a ruler or pour the water into measuring cups or graduated cylinders. Compare the amount of water in each. Why is less in the cans beneath the tree? Are all the cans under the tree filled to the same amount? Rain passing through a tree's leaves and coming to the ground is called "throughfall". What may have caused these result? Trees change the path of water. You might also have the students check the water coming down the tree trunk.

   B. *What are some reasons why all rain does not reach the ground? On a class field trip walk around the school grounds and examine different tree species. Look at the overall tree--how dense is the crown--can you see daylight when you look through the crown or is it very dense? Feel the differences in leaf and bark surfaces--which are smooth, which are rough? Compare the sizes of leaves. Hypothesize which species can hold the most water and allow the least to get through (throughfall). Collect throughfall under these different species. Were your hypotheses right? Infer why you were right or wrong based upon your initial hypotheses. What other things may have come into play? Some things they may have included:*
      - *Length of the storm*
      - *Wind*
      - *Exact placement of throughfall containers*

4. As a closure describe a watershed and its affects on water. A watershed is an area contributing water to a stream, river, or lake. Point out at the station or in a photograph, the effect slope and soil type has on the quantity and quality of water runoff.

MIDDLE CHILDHOOD ACTIVITIES

Materials: for the class
- 24 small rocks
- 9 plastic pans or waterproof containers 45 cm (1.5 feet) or greater in length and width
- 1 large bag of top soil or potting soil
- 4 - 5 strips of turf 30 cm (1 foot) long
- 1 - 2 jars per group (1 liter or quart size)
- 1 large bag of clay

Involve the students in the following activities:

1. Review the results of student discussion and activities performed during the *Exploration*. Answers should be provided to the inquiry questions, A-G, in response to questions. The students' responses, being the first attempt at solving the question, should be incorporated into the answers provided.

2. Pose a question to the class:

   A. Where does water to support life on land come from? Students may create a list on the board. Direct student attention to runoff water and collection basins.

   B. How does vegetative covering affect the quality and amount of water flowing from a watershed?

      (1) Teacher should show transparencies or pictures depicting watershed features, see Figures 3 -6.
      (2) Ask students to construct model watersheds. Divide the class into three groups.

TO THE TEACHER:

During drawing or construction bring out the concepts of divide, watershed and headwaters. High places of land situated so that water on one side flows in the opposite direction to the water on the other side are called a divides. The area on one side of the divide that provides water to a central point is called a watershed. Small watershed streams are called headwaters of the river systems.

3. Each group will construct 3 watersheds.

WATERSHED 1	Fill a pan with topsoil. Mound up soil in a U shape on one side so as to form a slope. The other side of the pan should have no soil and serve as a water collection point.
WATERSHED 2	Fill a pan with topsoil, clay, and rock. Mound up soil in a U shape on one side so as to form a slope. The other side of the pan should have no soil and serve as a water collection point.
WATERSHED 3	Fill a pan with sod pieces. Mound up soil in a U shape on one side so as to form a slope. The other side of the pan should have no soil and serve as a water collection point.

WATERSHED 4
(Optional)

Fill a pan with topsoil. Mound up soil in a U shape on one side so as to form a slope. The other side of the pan should have no soil and serve as a water collection point. Put leaves and some twigs on top of the soil to simulate a forest floor. (Later you might emphasize the benefits of this layer including a) dissipation of rain drop energy and b) as an insulator for the soil keeping it cool and reducing evaporation.

A. Now slowly pour or sprinkle approximately 1/2 liter (quart) of water over each watershed. Collect a sample of water at the base of each pan. Use Figure 4 for analysis or results.

	1	2	3
Appearance			
Odor			
Acid/Base			
Particles			

Figure 4
Watershed Analysis

4. Compare the results from the different groups on the board.

5. Pose inquiry questions:
   Suppose each watershed was 1) in a steep mountain area, and 2) in a flat plains area:
   a. How would each affect the water quality?
   b. The total water supply?
   c. Would water flow at the same rate from each?
   d. How might wise watershed management affect the water quality and supply?
   e. Why is this important?

6. Discuss the results of the activity as a whole group. Compare this data to the samples tested in the *Exploration Phase.* Can inferences be made about the origin of the *Exploration* water samples used earlier?

7. *Optional: Field Trip.*

   A. *On a school grounds field trip, ask (or show) students to locate a watershed. Ask students to record physical observations.*

      - *Terrain*
      - *Vegetative Covering*
      - *Rock types*
      - *Slope*
      - *Location of runoff*

   This should be done with narrative, tables and drawings.

   B. *Have students test waters for:*

      - *Clarity/particles (turbidity)*
      - *Odor*
      - *Microorganisms*
      - *Dissolved solids*
      - *Acid/Base (pa) (See Student Handout #3)*
      - *Also, oxygen and other tests are possible: contact a chemistry teacher at your local high school or community college, or scientist at your soil conservation office.*

   C. *Ask students to generate hypotheses concerning resultant data in relationship to the watershed and water quality.*

   D. *Discuss and compare hypotheses.*

8. Provide a closure to the activities completed. Make connections between the water quality and watershed characteristics. Review briefly the investigation techniques used in finding results on the questions posed.

EXPANDING THE IDEA PHASE

In the final learning cycle phase the student must use and apply facts, concepts and relationships concerning water quality and watershed management. Students should refer to cumulative information notes, fact sheets, etc. New contexts and different ways of looking at the ideas explained in the earlier part of the lesson should be attempted now. Following Expanding The Idea, the teacher should check student outcomes with a quiz; performance test and/or discussion.

EARLY CHILDHOOD ACTIVITIES

Involve the students in the following activities:

1. Reviewing the results of *Inventing the Idea* activities, ask:

   A. What would happen if all of the precipitation had run into a river? Does this ever happen?

B. Discuss the means by which watershed managers control the amount of water flow and why. Make transparencies of Figures 3 and 4 and discuss with class.

2. Using potting soil and large pans have students construct a watershed which produces poor water quality.

3. Ask students to draw a watershed which produces good water quality.

4. *Optional: Lead the students into defining and describing kinds of water pollution. Guiding questions which can be used are:*

   - *Why can't you see some of the pollutants?*
   - *How many of water pollutants occur in nature or naturally?*
   - *Which one of the watersheds would you drink from now? Why? Why not?*
   - *How can watersheds be managed to make water drinkable?*

   As the questions are asked fill in responses on a chart:

Water Pollution Discussion Chart

Why can't you see some of these pollutants?
Which pollutants are found in nature?
Which ones would you drink?
What pollutants could be cleaned up?
How can we clean them up?

MIDDLE CHILDHOOD ACTIVITIES

Materials: for the class
- 1 map displaying a watershed, a topographic map of an area would be useful.
- 4-6 local, state, or county maps, or 4-6 globes

TO THE TEACHER:

Since there is a great deal of material in this module some of the problems described in Student Handouts 4 - 7 may be used or modified for student evaluation.

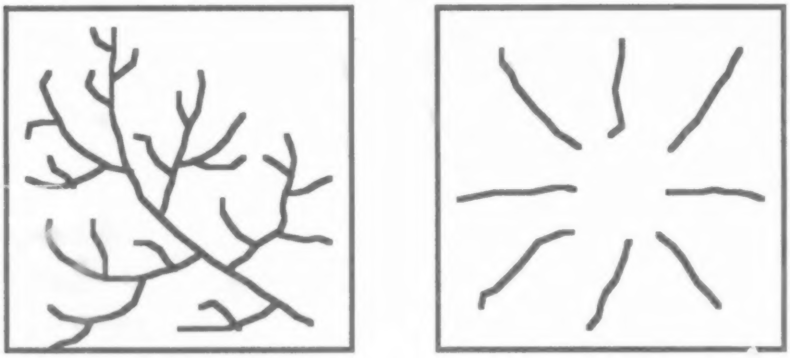
Involve the students in the following activities:

1. Ask students to draw maps to illustrate several watersheds and adjacent areas, each related to a different water quality. The students may be asked to state hypotheses concerning changes taking place in watersheds and draw the resultant effects.

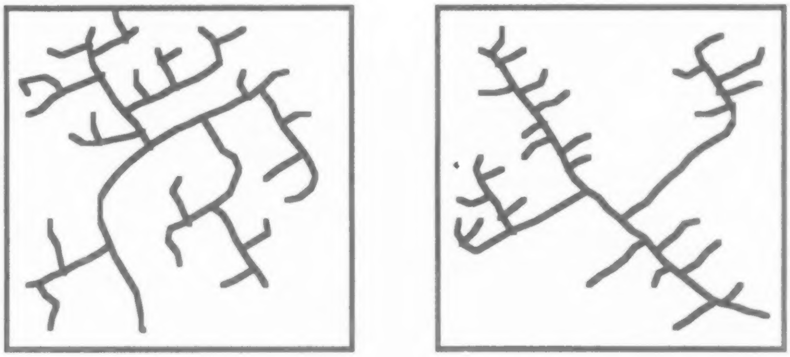
2. Using local, state and/or continental maps or globes ask students to locate large scale watersheds, divides, and headwaters. Watershed drainage patterns also could be identified - dendritic, tree like and fan shaped as well as parallel and radial drainage patterns. Other river terms might also be reviewed. See Figure 5.

Figure 5

DRAINAGE PATTERN TYPES



Dendritic Radial



Rectangular Trellised

3. Ask students to locate major cities in the state or region on a map and determine their main sources of water for human and industrial use. Are all the cities situated to be able to make use of a large watershed?

4. Set up a series of class investigations designed to help students understand how water originates in a watershed, the role of evapotranspiration, and how characteristics of watershed vegetation affects watershed runoff. See Student Handout 4. The students should work in small groups.

5. Present an Invitations to Discovery to the class found in Student Handouts 5, 6 and/or 7. Group the students, 3 - 5 members per group. You may ask them to graph the data. This provides a less abstract and more visual grasp of the data

table. Provide graph paper for line or bar graphs.

TO THE TEACHER:

Students should develop an understanding of watersheds and be able to identify watersheds on maps. Students should have developed skills to evaluate water quality in local watershed regions and use inferential skills to draw conclusions and make appropriate recommendations concerning watersheds and management. Additional questions might include:

- How many people do you think could live off the water in a particular stream?
- Could we take measurements to determine the amount of water flowing through a given point in this stream?
- What might happen to this environment if we piped all water at this point to a given community?
- What might affect the amount and quality of life in a given stream?
- How important is a stream to a community? To the environment in an immediate area?

FINAL EVALUATION

Student evaluation should involve the written records and the skills students use to draw conclusions and make appropriate recommendations. The science processes in this module are the primary focus. Evaluation should be based on the progress each individual makes as the unit develops. Additional evaluation should consist of a short test for evaluating terms and problem questions involving inferential thinking skills concerning water quality and watershed characteristics. One or more of the student handouts or modifications of them could serve as one part of the student evaluation for this module.

STUDENT HANDOUT 1

Record of Water Runoff

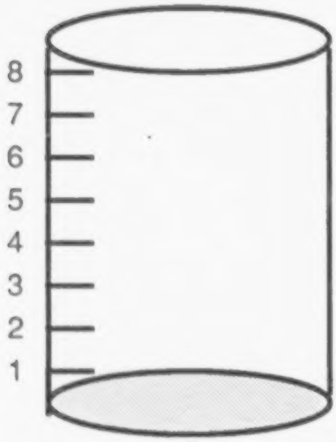
A. How Fast

	Exposed Soil			Turf		
Tube Length	Water Runoff Rate Check off speed					
	fast	slow	none	fast	slow	none
5 inch						
6 inch						
7 inch						

B. How Much

After the water has been drained through the soil, color each cup below to the level of water found in each plastic measuring cup.

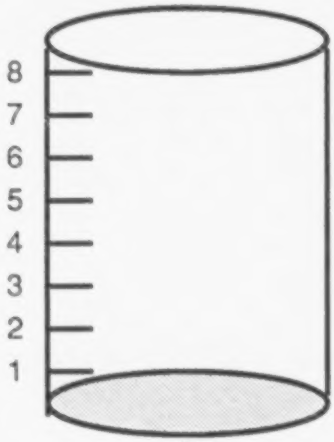
Exposed Soil



A

Low Slope

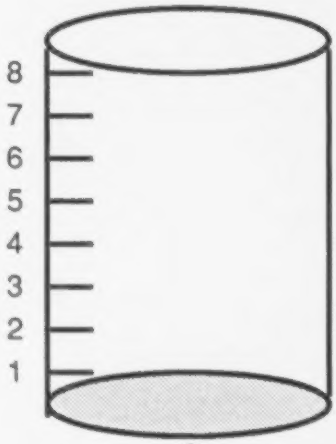
Exposed Soil



B

Medium Slope

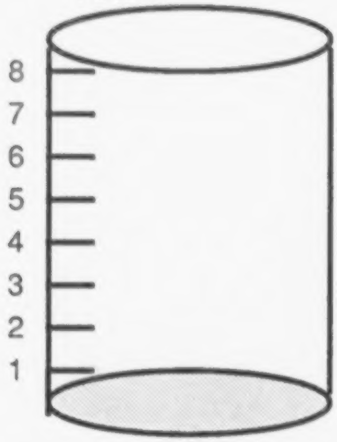
Exposed Soil



C

High Slope

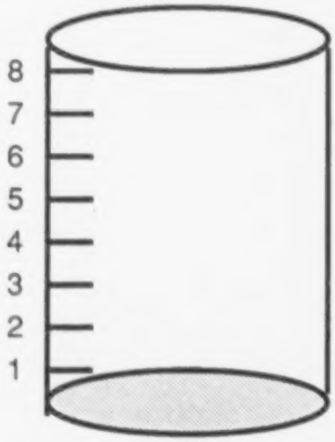
Turf



A

Low Slope

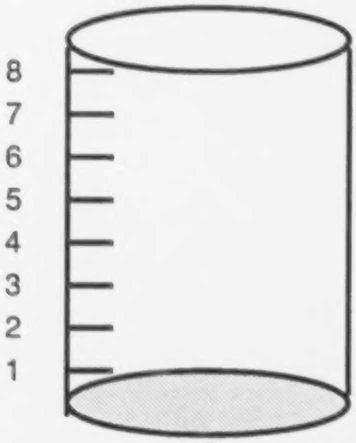
Turf



B

Medium Slope

Turf



C

High Slope

STUDENT HANDOUT 2

Types of Impurities in Water

A. Suspended Particles - These are particles with diameters above 1 micron (.001 millimeter) and large enough to absorb light. They make the water look cloudy or murky.

B. Colloidal Particles - These are very small particles smaller than 1 micron. The particles do not settle to the bottom of the containers. The particles pass through holes of most filter media, therefore they cannot be removed from water by settling or ordinary filtration. They do make water cloudy when viewed at right angles to a beam of light. An example would be to pour a little milk in a glass of water.

C. Dissolved Matter - These particles do not settle out, cannot be filtered and do not make water cloudy even when viewed at right angles to a beam of light. Particles are the size of molecules (.0000001 millimeters). If they have an electric charge they are called ions.

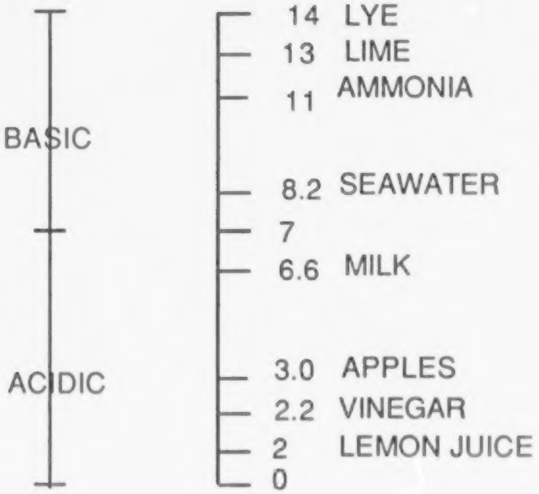
Using the water sample provided, complete the chart below.

	Sample 1	Sample 2	Sample 3
Appearance and Color			
Microscopic Organisms			
Odor			
Acid/Base pH			
Particles Residue			

Note: Put a drop of the sample on a microscope slide to observe for microscopic organisms.

STUDENT HANDOUT 3

pH Scale


14 LYE
13 LIME
11 AMMONIA
BASIC
8.2 SEAWATER
7
6.6 MILK
ACIDIC
3.0 APPLES
2.2 VINEGAR
2 LEMON JUICE
0

STUDENT HANDOUT 4

Where Does the Water Go?

Class Experiment 1

Place two 5-pound coffee cans or other large containers out in the open before a rain storm. Place a three or more identical containers under a tree before the same storm. Space these cans at different points under the tree. After the storm has ended measure the depth of water in each container with a ruler or pour the water into measuring cups or graduated cylinders. Compare the amount of water in each. Why is less in the one beneath the tree? What factors may have caused this result?

Class Experiment 2

Go around the school grounds and examine different tree species. Look at the overall tree--how dense is the crown--can you see daylight when you look through the crown or is it very dense? Feel the differences in leaf and bark surfaces--which are smooth, which are rough? Compare the sizes of leaves. Hypothesize which species can hold the most water and yield the least to throughfall. Collect rain throughfall under these different tree types. Were your hypotheses right? Theorize why you were right or wrong based upon your initial hypotheses. What other factors may have come into play? Some factors may have included:

- Length of the storm
- Wind
- Placement of throughfall containers

Class Experiment 3

Throughfall is the precipitation that falls through tree canopies or drips off leaves and branches. Precipitation also can run down the tree trunk--this portion of precipitation is called stemflow. Another portion of precipitation never reaches the ground because it is captured by the leaves and branches and eventually evaporates. This loss is called interception or evaporative loss. Therefore, the amount of throughfall is always less than the amount of precipitation. Design and carry out an experiment to measure the amount of evaporative loss of a particular tree on the school grounds. (Assume water from down the trunk or stem is zero.)

STUDENT HANDOUT 5

Invitation to Discovery 1

Precipitation in the open and throughfall under 3 tree types (species) were sampled for 3 storms. The results were as follows:

	open (mm)	Throughfall (mm)		
Storm #	Precipitation amount	sugar maple	pin oak	sycamore tree
1	12.44	7.21	8.68	9.35
2	26.43	16.95	19.60	22.61
3	7.97	5.34	5.87	6.62

TO THE TEACHER:

Conclusions:

From these data we see that throughfall quantities were always less than precipitation. Also, from this we see that sugar maples always had the least throughfall.

It appears that there is something inherently different between species because the sugar maple always intercepted more precipitation than pin oak which intercepted more than the sycamore tree. The reason for these species' differences may be due to many things, including:

- Leaf size
- Leaf shape
- Canopy density
- Bark roughness
- Leaf roughness

Design (and carry out) an experiment to show the effect of one of these variables. Can you think of additional variables?

STUDENT HANDOUT 6

Invitation to Discovery 2

During a drought, a city's reservoir is running short of water. If trees were cut on the watershed around the reservoir, perhaps less water would be used by the trees for transpiration and more water would be available to fill the reservoir. But no one is sure what type of cutting would be best for increasing water yields and for keeping the water clean (i.e., free of sediment from erosion). So three different cutting experiments are tried on three watersheds--a clearcut, a diameter limit cut, and an extensive selection cut.

The specifics on each cutting method are as follows:

- Clearcut - Cut everything
- Diameter Limit - All trees over 17" diameter
- Extensive Selection - Selected trees over 11" diameter

The water flowing in the stream of each of these watersheds was measured for 4 years. The volumes in millions of gallons above what are predicted with no treatment are given below:

	Year			
Treatment	1	2	3	4
Clearcut	4.4	10.2	6.8	7.0
Diameter Limit	1.0	2.6	1.4	0
Extensive Selection	2.4	1.7	0.2	0

Describe the conclusion you would draw from this data.

TO THE TEACHER:

The clearcut had the greatest impact on increasing water yields because more trees were removed and less water was used for transpiration by the vegetation. More precipitation traveled through the soil and into the groundwater and streams, and eventually more water would be added to the reservoir.

The clearcut influence also lasted the longest, again, because more vegetation was removed from the site.

But, what may have happened to water quality, erosion of the watershed and additional cost of water purification?

STUDENT HANDOUT 7

Invitation to Discovery 2 (Continued)

The water quality of the water in these streams also was monitored because clean water is needed for drinking purposes.

Over two hundred water samples, one each week for 4 years, were taken and ranked according to the number of clean and muddy samples found. The data are shown below in Table 1 and graphed in Figure 8.

Table 1. Number of samples taken in each cutting typed, identified by sediment load.

	Water Sample Types		
Type of cutting	Clear	Somewhat Muddy	Very Muddy
Clearcut	125	64	14
Diameter Limit	171	25	7
Extensive Selection	195	8	0

You may want to graph these results: What conclusions can be drawn from this data?

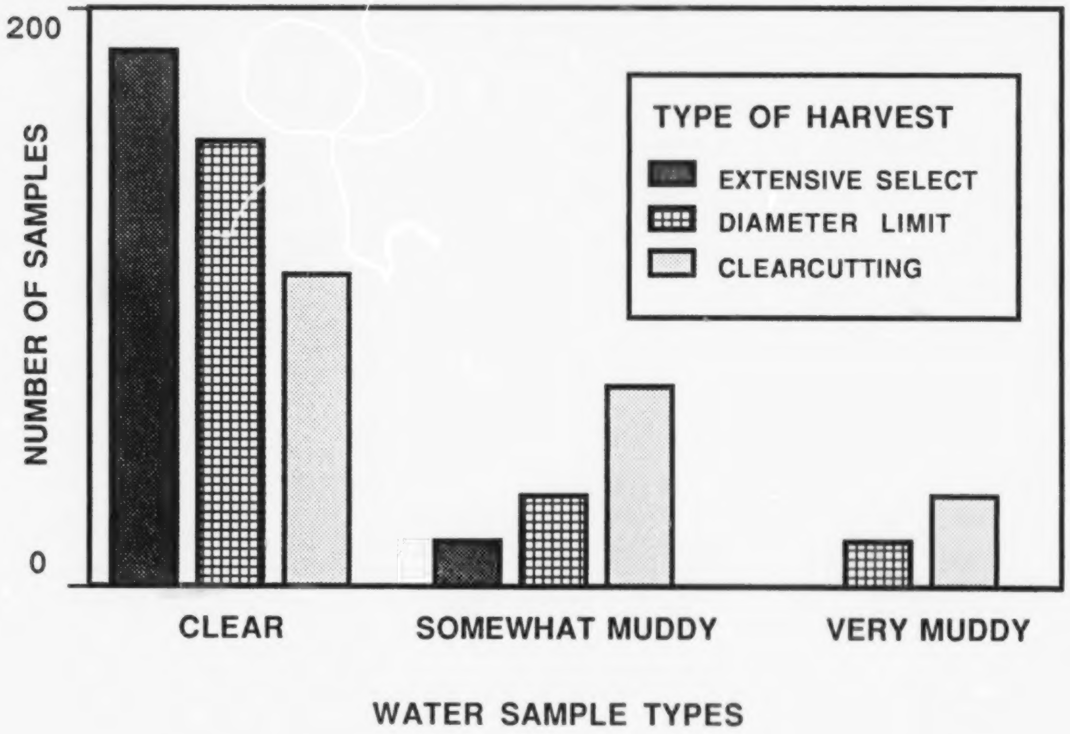
TO THE TEACHER:

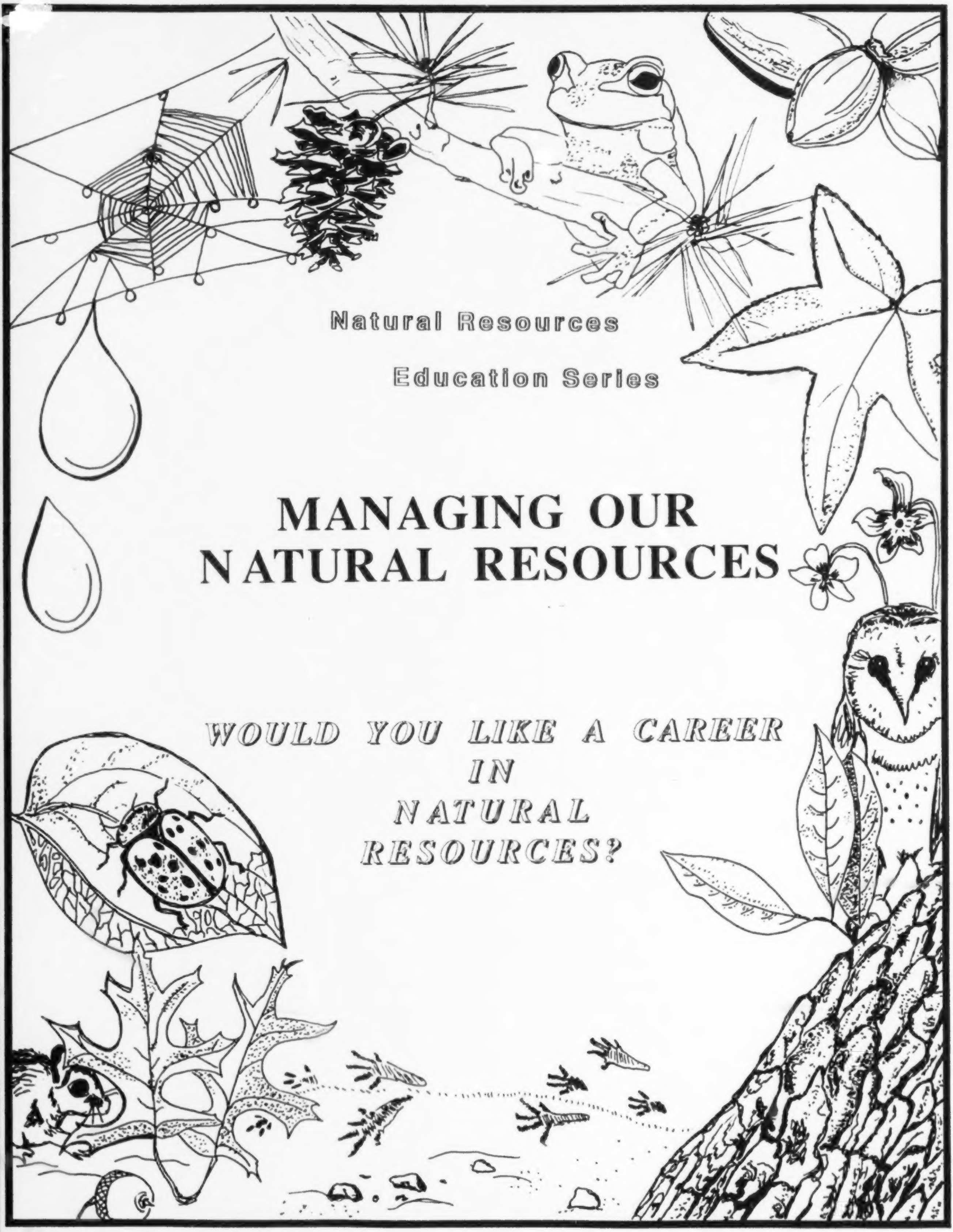
The clearcut had the muddiest samples, but only a small portion of all of the samples were very muddy. Generally, as more trees were removed, more soil entered the stream. However, the stream was muddiest generally only at the time of cutting and during severe storms. Water quality improves quickly (within 1 year) even after clearcutting, and the streams became clear.

It should be noted that it was not the cutting intensity that caused the muddy streams, but the lack of care in the forest product removal that caused the problem. This suggests the importance of the litter layer in forests. Keeping this later intact can help prevent erosion.

Figure 8.

SEDIMENT CONTENT OF WATER SAMPLES AFTER HARVEST





Natural Resources

Education Series

MANAGING OUR NATURAL RESOURCES

WOULD YOU LIKE A CAREER IN NATURAL RESOURCES?

BEST COPY AVAILABLE

The writing, development and, production of the **NATURAL RESOURCES EDUCATION SERIES** is a joint project with collaboration of project directors Dennis W. Sunal, The University of Alabama, and Mary E. Haas, West Virginia University, and the U.S. Forest Service. Partial funding was provided by the U.S.D.A. Forest Service. The initial author and series editor was Dennis W. Sunal. Revision of individual modules was carried out with the help of Mary E. Haas, and Cynthia S. Sunal. Assistance in creating appropriate activities, proof reading, and creating art work by computer for the many editions was provided by Jon Berninzoni, Elwin Dickerson, Tracy Johnson, Jane McGinnis, and Sukhwindar Singh. Final editing assistance on the text and artwork was performed by Audrey Rule. William Kline, Jr. assisted in training the original trial teachers. Content reviewers were specialists in the various module topics at the U.S. Forest Service including Monongahela National Forest staff members, Theresa Anne, Randolph Harrison, Linton Wright, and Harry Mohoney, and Northeastern Forest Experiment Station, Timber and Watershed Laboratory staff Pamela Edwards, David Helvey, James Kochendorfer, and Clay Smith. Teachers in the Randolph County, West Virginia Schools who first taught the modules and made recommendations for revisions were: Sandra Arbogast, Sara Basil, Ann Deloach, Karen Hall, Richard Leitner, Elizabeth McDonald, Linda Moore, Sharon Moss, Pam Mullennex, Jeff Ranhart, Theresa Skidmore, Rachel Snavely, Charles Swecker, Nancy Taylor, Angela Vance and Rebecca Wallace.

The **NATURAL RESOURCES EDUCATION SERIES** is designed to supplement textbooks with active learning lessons for students in the primary and middle childhood grades (K-8). The series consists of Understanding Our natural Resources Teacher's Guide and 12 Modules including Appreciation of Natural Beauty, Soils and Plant Growth, The Water Cycle, Natural History of a Tree, Recipe for Tree Growth, Tree Growth and Environment, Forest Processes, Managing Our Forest Resources, Growth of a Forest, Interactions of Forest Plants and Animals, Natural Watersheds, and Managing Our Natural Resources.

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MANAGING OUR NATURAL RESOURCES

MANAGING OUR NATURAL RESOURCES?

WOULD YOU LIKE A CAREER INVOLVING NATURAL RESOURCES?

BACKGROUND INFORMATION FOR TEACHERS

This module would be appropriate with many biological and earth science related science textbook and teacher prepared units. The module would be a useful addition to any of the other modules in the Natural Resources Education Series. This module will focus on occupations and career awareness related to the broad field of planning, supervising, and performing tasks in the management of our natural resources for the benefit of all. This involves concern and reasoned understanding of the fragile earth environment and a sense of stewardship for the planet.

People who work in the area of natural resources are often perceived as employed by a government agency. However, many are employed by private industry. The work often involves assisting and educating the public in how to manage our natural resources of land, water, and forests effectively. These individuals must be able to develop good relationships with people. Some individuals are required to do very technical and highly specialized jobs which require working in laboratories, performing measurements, and using computers. Others work in the outdoors gathering data or carrying out projects that they or others have planned.

Work in natural resources as a life-long career endeavor may require knowledge in science and social sciences, and skills in management. This is especially important when dealing with public policy making, planning projects, and interpreting the results of research efforts. Education for a career in natural resources must, therefore, be broad in scope. Knowledge of botany, zoology, geology, chemistry, and physics may also be essential. Additionally, familiarity with business administration, accounting, writing, speech, English literature, philosophy, psychology, government, geography, economics, mathematics and sociology is useful in the practice as a professional.

The men and women who work with our natural resources of forests, soils and water must acquire special knowledge that equips them to guide, instruct and advise others in a professional manner. The development of specialized training institutions and programs is one of the signs that an occupation has developed into a profession. Other indications include the publication and accumulation of a technical literature, research activities, ethical concerns, and improvement of technical practices through the application of the results of research.

Some occupational titles in the natural resource profession include:

Forests
forester (and/or research)
geneticist
plant scientist
forestry technician
forestry aid
logger/sawyer
forest products technologist
ranger
wildlife biologist
landscape architect
archaeologist
entomologist
pathologist

Soils
soil conservationist
soil conservation technician
soil scientist
range conservationist
engineers - specializing in erosion control on land or streams or other soil-related areas
agricultural economics specialist
geologist

Water
hydrologic technician
aquatic entomologist
aquatic biologist
fishery biologist
hydrologist
hydraulic engineer
erosion and sedimentation specialist
engineers - specializing in water supply systems, dams, or other soil-related areas

Some other occupational titles working in all fields include:

engineering technician
clerk typist
statistical assistant
computer programmer
chemist
biological laboratory technician
business management assistant
accountant
landscape architect
custodian
maintenance supervisor
outdoor recreation planner
statistician
cartographer
equipment operator
trainee
draftsman
archaeologist

OBJECTIVES: Choose those appropriate for your students.

-Define the many roles of natural resource occupations concerning forests, soils, and water.

-Develop an understanding of the diversity of and relationships between natural resource occupations.

-Appreciate the careers in the natural resource science area.

-Develop personal insight into their own goals and judge their interest and compatibility for a career in the natural resource science area.

EXPLORATION PHASE

TO THE TEACHER:

The initial phase of exploration involves activities using observation and other science process skills to help students, on their own, discover the diverse skills and knowledge necessary for careers in the natural resource science area. The teacher should use this time to organize groups, observe interactions and permit students to investigate possibilities themselves. Students should be asking questions, gathering firsthand information and making connections to their previous experiences in and out of school that are related to natural resources. Ideally, students should be confronted with a problem or event which cannot be explained entirely by their past knowledge and will require the student to ask questions and predict outcomes.

EARLY CHILDHOOD ACTIVITIES

Materials: for the class
- pictures or drawings of an empty lot and a second picture of the lot after it is developed to include a school, parking lot, landscaping, etc. (or see Student Handout 1)

Involve the students in the following activities:

1. Show the students the "before" drawing of the vacant lot and the "after" drawing. Have them identify differences.

2. Brainstorm the types of events needed to create the changes seen.

3. Ask the students to describe the types of jobs held by people who participated in changing the field or empty lot into the school parking lot, landscaped areas, and/or school building. List the job categories suggested by the students.

MIDDLE CHILDHOOD ACTIVITIES

Materials: for the class
- list of natural resource occupations for either forests, land, or water on the blackboard or transparency, (see Background in this module)
-Student Handout 3A, 3B, or 3C

Involve the students in the following activities:

1. Ask students who have visited a national or state forest or park to relate some of the things that they saw and did on the visit. List the descriptions on the board. With the students examine some pictures or tourist guides of a national or state forest.

2. Recall activities or problems that natural resource workers might have to deal with from your previous related units of study in the **Natural Resources Education Series**, or in their science textbook.

3. *Optional: Ask a guest speaker(s) working with forest, soil or water resources to speak to your class. This could include government agencies such as the local offices of the U. S. Forest Service or Soil Conservation Service, or private businesses such as the local electric power company. Have the guest(s) bring in appropriate tools used in their career area. Ask them to describe their training, job responsibilities, and special skills used on the job. The students should discuss questions they wish to ask before the person arrives.*

TO THE TEACHER:

For the following activity and remainder of the *Middle Childhood Activities,* choose one specific career area to work on. Choose a forest, soil or water related set of careers. See introduction for a brief listing of occupations in each natural resource science area.

4. After student have examined one or more of the listed career sets shown on the blackboard, arrange the students into groups of three or four. Assign roles of recorder and reported. Have the groups perform the following tasks and answer the related questions. Tell the groups that they should be able to give reasons for their answers, but that not all students in the group must agree on all of the answers.

TASKS FOR GROUPS TO PERFORM:

a. Make a list of the kinds of activities that you think a person who works in forests, soils or water (teacher should make choice) would do on a typical day.

b. List some tasks which would need to be performed seasonally or only a few times during the year.

c. Next to each of the activities have the students give a skill or particular knowledge that the worker would need to successfully perform the task.

LOOKING AT YOUR LISTS, ANSWER THE FOLLOWING QUESTIONS:

a. What proportion of the day and year do you think people who work in this career area spend indoors and outdoors?

b. What type of an education is required for this career area?

c. What subjects are you studying/have you studied that would be of help in this career?

d. Is this an occupation that is best suited to people with certain physical characteristics?

After the groups have completed their tasks, gather the class together and call on a member of each group, the reporter, to describe the answers that they gave to the questions. To shorten the time ask each group to report on only one or two of the tasks or questions. Ask: Do the other groups agree with the statements made? Does any group have something new to add to the reporting group's answers? If time allows, library research or interviews can be used to add depth to the students' answers.

INVENTING THE IDEA PHASE

TO THE TEACHER:

During this phase of the learning cycle the teacher will play a more directive role. At this time the teacher may wish to refer to notes, background information, etc. The teacher may use inquiry techniques to reinforce exploration activities or simply demonstrate and explain some of the occupations. Students who were not able to answer the problems or events given in the *Exploration Phase* should be led to an appropriate response at this time.

EARLY CHILDHOOD ACTIVITIES

Materials: for the class

- badges or drawings of symbols to be worn by the students for the following jobs: secretary, fire fighter, chemist, logger, truck driver, computer operator, ranger and planter (see Student Handout 2)

Involve the students in the following activities:

1. List the names of a few of the jobs of the people who changed the field into the school grounds, as discussed in the *Exploration Phase*. Two columns might be listed on the board titled Differences and Who Made This Difference (job name).

2A. The teacher should show a few pictures of natural sites containing forest, soil and water resources and buildings or people connected with management of these resources from your local region. While showing each picture ask, "Who works here?" "What does this person do?" If the students do not come up with jobs, resource management job names should be suggested. For each job name provide a description of what that person does during a typical day. Sample job titles can be found in the Background Information for Teachers. Sample job descriptions can be found in Student Handout 3. You may wish to simplify these statements.

B. For each job named give a badge to sample students in the class, with the job title written on it (see Student Handout Sheet 2). Cut out or have students cut out badges. Pin or tape badges on selected students. Randomly mix job categories among the boys and girls. You may select some students who would not be typical for each job category. For example choose some girls for logger or research forester and some boys for clerk typist or computer programmer analyst.

3. After selection and description of job roles have each student act out one or two actions typical of each job. Holding up a picture depicting a natural resource area, ask "What would you do if you were at this place?" The teacher should distribute the symbols to small groups of students who then act out how this job would be done.

4. Finally the students select one of the jobs that they think they would most like to do and draw a picture of themselves doing the job.

5. *Optional: If time allows invite a woman or man who works in resource management to come and tell about her or his job. Have them bring samples of the tools, clothing, or work materials that they use to perform their job.*

6. For closure of the *Inventing the Idea Phase*, discuss with the students the diversity and interrelatedness of jobs necessary to effectively manage natural resources for the good of all.

MIDDLE CHILDHOOD ACTIVITIES

TO THE TEACHER:

For the activities below, choose only one career area, such as forest, soil, or water. This should be the same career area students selected in the *Exploration Phase*. Have the students work in small groups to answer and discuss questions during this activity. At the end of the lesson have group reports for a whole group summary.

Materials: for the class

- copies of the job ads for natural resource workers. Choose a Forest, Soil, or Water Career Area. See Student Handout 3A, 3B, or 3C.

Involve the students in the following activities:

1. Ask students to list the kinds of tasks that they do well or would like to do when they become adults and have a job. Where would they like to live and what would they want to do for fun when they're not working?

2. Next have each group of students examine the complete set, 3A, 3B, or 3C (or just one or two descriptions per group), of job descriptions and decide:
    A. the kinds of training an individual needs and how they would secure the training.
    B. the tasks that the employee would do at work every day.
    C. the tasks that the worker would do only a few days of the work year.
    D. what they think would be the most difficult part of each job and explain why that is the case.
    E. which of the jobs pays the most and give reasons for the decision.
    F. if they would like to have such a job and give reasons for their decision.

After the students share their answers with the class, have them list some adjectives that describe the work that forestry, soil, or water workers do. Write these on the board.

EXPANDING THE IDEA PHASE

TO THE TEACHER:

In the final learning cycle phase the student must use and apply facts, concepts and relationships. Students should refer to cumulative information notes, fact sheets, etc. New contexts and different ways of looking at the ideas explained in the earlier part of the lesson should now be attempted. Following this phase, the teacher should check student outcomes with a quiz, performance test, and/or discussion.

EARLY CHILDHOOD ACTIVITIES

Materials: for the class
- pictures of well managed and polluted or poorly managed landscapes (use magazines, encyclopedias, textbooks or Student Handout 4)
- pictures of people who are responsible for good management of natural resources (use magazines, encyclopedias,or textbooks)

Involve the students in the following activities:

1. Show the students pictures of polluted or poorly managed landscapes. These may be found in magazines, encyclopedia, textbooks, or Student Handout 4.

2. For each picture, ask the students to suggest ways in which the environment can be improved.

3. Finally ask, "Who will do the work?" Ask students to describe a job function and think of a job name for each task.

MIDDLE CHILDHOOD ACTIVITIES

Materials: for the class
- 6 cards describing various development projects for a piece of land (Student Handout 5)
- land use problem and map of problem area (Student Handout 6)
- job description questions (Student Handout 7)

Involve the students in the following activities:

1. Form groups of 4 four to five students. Assign roles of consensus leader, recorder and reporter. Ask the groups to select a land use problem from Student Handout 6. "How will this land be used?" The group may choose a development such as ski resort, nature center with guided tours of area, sailing club, camp ground, tree farm, hunting center, state park, or mining or lumbering operation, see Student Handout

6. The following projects are suggested:

    1. Surface mining of available coal. This action requires roads to be constructed. Include these on your diagram.
    2. Harvesting timber requires that roads be constructed . Locate these on the diagram.
    3. Leave an area as wilderness. This requires selling the idea to large numbers of people and eliminating traffic in the wilderness area.
    4. Develop recreational use (you select the appropriate type(s)). This requires an entrance road and a parking lot. This may also require other buildings, trails, and an information center.
    5. Provide an area for hunting and fishing in proper seasons. This requires an entrance road and parking.
    6. Develop this area for a large shopping mall and for recreation. This may require leveling the hills, filling in the lake, building parking lots, a drainage system, and buildings.

2. Ask the students to answer their selected problem by completing the land use map in Student Handout 6. Ask the groups to simulate a meeting where they are developers of a specific project. The legend tells what the symbols on the diagram represent. There is some extra space in the legend where the students can add symbols that describe their choice for the use of different parts of the land. Students should draw the symbols in the legend and also on the diagram where they wish to locate their projects. When they complete their planning map you ask them to share it with the class and give reasons for their choices and the locations of projects.

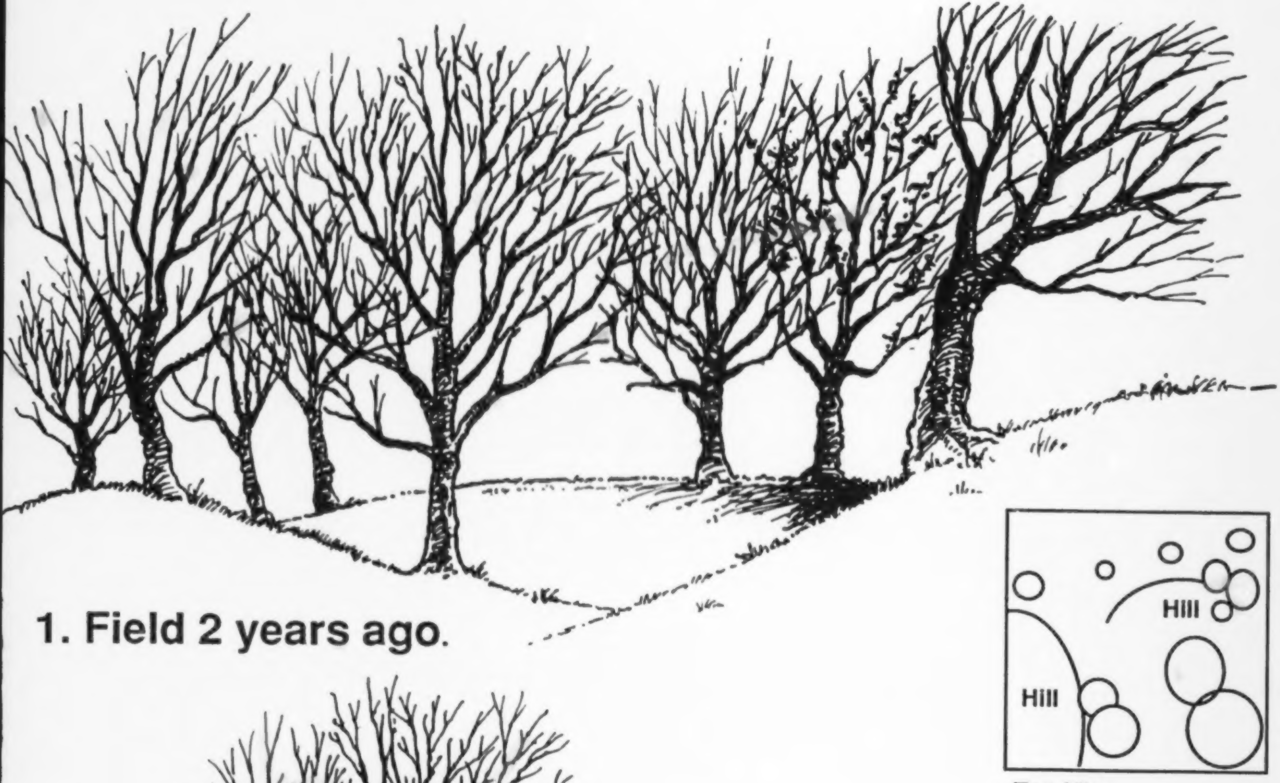
3. After the class presentation in activity 2 above, ask each groups of students to write job descriptions for the people they hope to hire in this project. Distribute student handout 7. Job descriptions are shared and evaluated for their accuracy. When they complete their descriptions ask the groups to share them with the class and give reasons for their choices. Students in the class should be able to discuss which jobs are of interest to them. If time permits students can go through the process of applying and being interviewed for the jobs.

FINAL EVALUATION

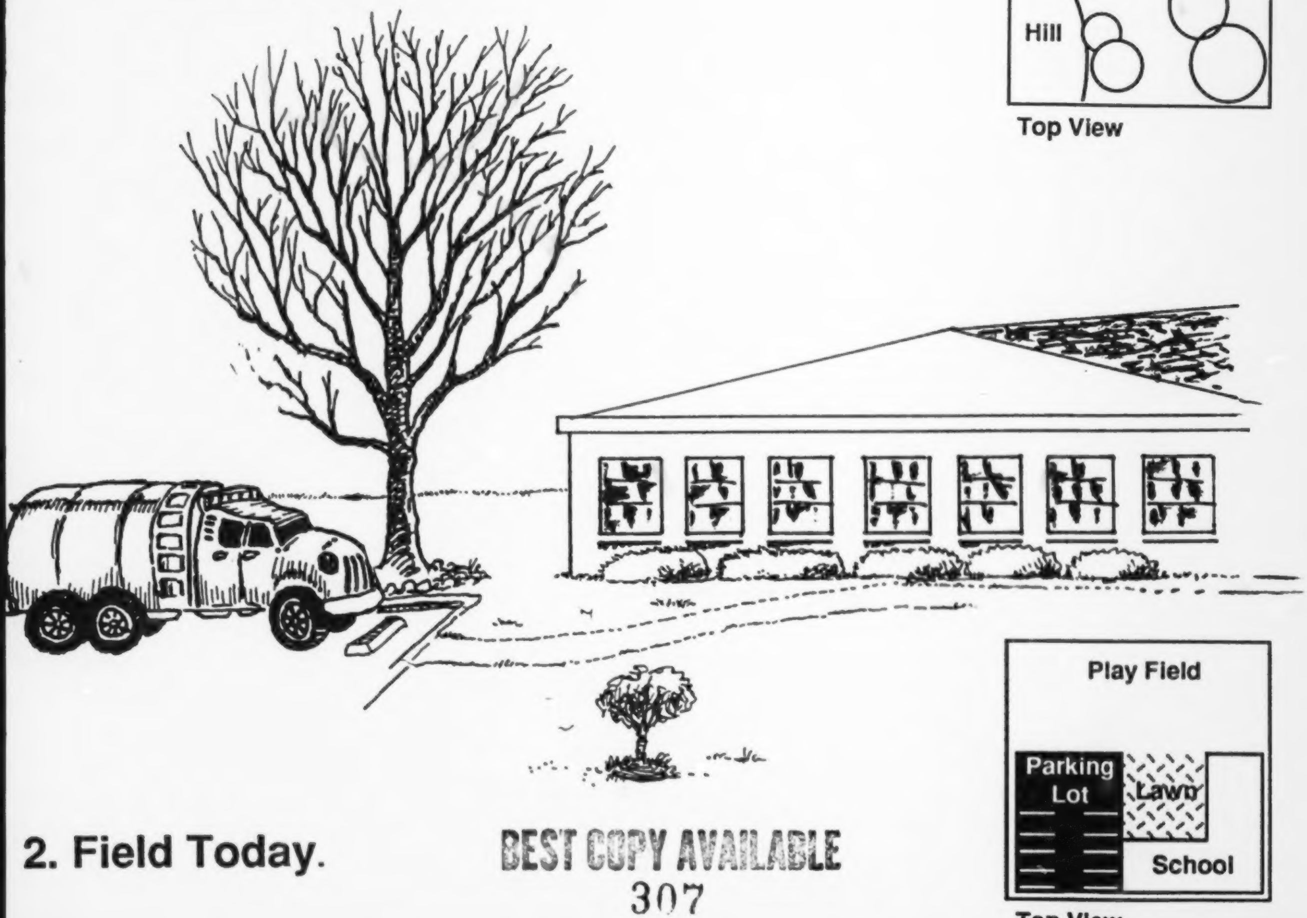
Many diverse jobs are done by people in resource management. Some of the people work outdoors all of the time, others may work indoors almost all of the time, while still others work both indoors and outdoors. Evaluation of the unit should allow students to draw, participate, or describe in a creative format adult roles in relationship to natural resources. This may also relate to volunteer activities for students and adolescents in the local area or current knowledge and attitudes toward natural resources and people associated in various relationships with local natural resources.

STUDENT HANDOUT 1

An Empty Lot at Two Different Times


Hill
Hill
Top View

1. Field 2 years ago.

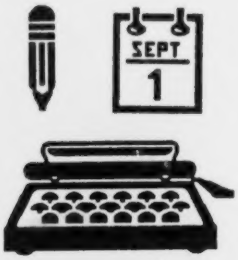

Play Field
Parking Lot
Lawn
School
Top View

2. Field Today.

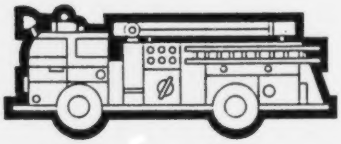
BEST COPY AVAILABLE

STUDENT HANDOUT 2

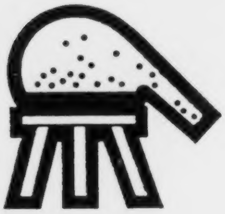
Symbols for Forest Jobs



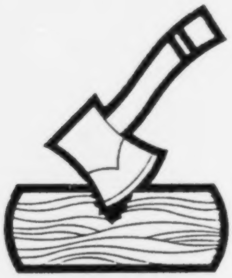
SECRETARY



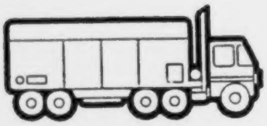
FIRE FIGHTER



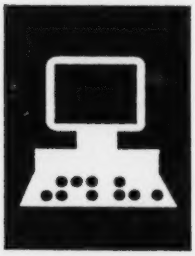
CHEMIST



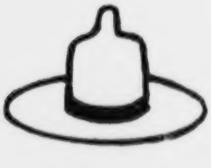
LOGGER



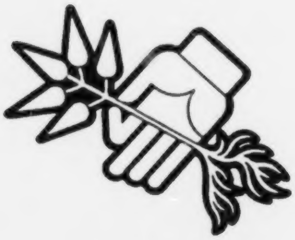
TRUCK DRIVER



COMPUTER OPERATOR



RANGER



PLANTER

STUDENT HANDOUT 3A

Job Description Ads

Forestry Positions Available

A1 Foreman

Full time, year round position as Foreman on a large wholesale Christmas tree plantation/nursery. B.S. in Forestry or Horticulture preferred. Must be capable of leading a crew and competent with machinery. Duties will vary and entail all aspects of Christmas tree production including site preparation, planting, transplant production, weed, insect, and disease control, shearing and harvesting.

A2 Procurement Forester

A hardwood mill in southern New Hampshire is seeking a person with good organizational and management skills to work throughout New Hampshire and Maine. Duties include purchasing land, logs, and timber.

A3 Supervisory Outdoor Recreation Planner

Serve as a principal assistant to the District Ranger in the Monongahela National Forest. Duties include responsibility for effectiveness of the District recreation, wildlife, minerals, and other resource programs, including formulation of goals, objectives, work plans, and recreational budget. The person is responsible for special use administration including wilderness areas, resorts, and recreation residences. The person also administers the District Visitor Education Program and has responsibility for the Districts Law Enforcement Program.

A4 Clerk-Typist

The position is located in the timber resource management office. Duties include clerical, typing, and statistical duties for the culture of Central Appalachian Hardwoods office section. This involves typing correspondence, tables, reports, graphs, and manuscripts following prescribed form, and for grammatical accuracy, and checking references cited in rough drafts. Familiarity with word processors, microcomputer operation and dictation equipment is essential. Duties also include maintenance of a library for projects and filling of requests for publications on silviculture. Preparation of library cards and files using the Oxford system is needed. Other duties will involve statistical processing, and tabulation and graphing of timber data on desk calculator or computer as directed by the section staff.

A5 District Ranger

Responsible for 346,000 acres of national forest land, supervisor of 32 employees, and administrator a budget of $800,000 per year. Experience in working with national forests in other capacities and a B.S. degree in forestry, landscape architecture, or other related area is required.

A6 Deputy Regional Forester

The candidate will work with the regional forester and other deputies in the overall planning, formulation, coordination, and direction of all programs and activities. Provides management direction to forest supervisors and staff directors. Major program areas include: timber, aviation, and fire management, lands and real estate management, range and watershed, minerals, engineering, state and private forestry, fire rehabilitation and recovery, administrative services, information systems, law enforcement, personnel management, planning and budget, information, and civil rights.

Office located in San Francisco.

A7 Tree Feller

Must have working knowledge and skill in the use and maintenance of a variety of logging equipment and tools. Candidate must be able to efficiently and safely cut, limb, and buck trees with a power saw, set chokers for skidding logs to a deck, and operate logging equipment. Will have responsibility for the daily training, scheduling, equipment maintenance, and requisitioning necessary to continue to perform the logging operation.

A8 Forestry Aide

The purpose of the position is to serve as a trainee member of a timber, recreation, fire, wildlife, and /or range crew. Duties include: receive training in the basic elements of practical forestry work; follow safety precautions affecting own tasks and those of others; clean campgrounds; assist in maintenance and construction; learn basics of marking trees for harvest; plant or thin trees; perform fire duties as qualified and assigned; record simple measurements and data in timber surveys, range studies, wildlife surveys, recreation use, and/or fire data.

STUDENT HANDOUT 3B

Job Description Ads

Soil Related Positions Available

B1 Soil Conservationist

To serve as field worker advising farmers, ranchers, land developers, and other land users in region. Must have experience with: methods for conserving soil, building farm ponds, offering technical help in land development, helping teachers begin outdoor laboratories, giving public lectures and slide programs, writing articles for newspaper and journals, carrying out research in specific areas. A college bachelor degree in soil conservation or a natural resource field such as agricultural education, agricultural engineering, or agronomy is required.

B2 Soil Conservation Technician

To assist soil conservationists in working with farmers, ranchers, land developers, and other land users in region. Duties include advising on conservation practices where needed and directing projects to solve problems. Included in this job will be making engineering surveys, and designing standard soil conservation practices such as waterways, terraces, and contour strip cropping systems. Also, the person will be responsible for checking progress and results of projects already completed and to provide land users with planning help for projects. Experience necessary includes knowledge of farm, ranch, or land management operations and familiarity with soil and soil conservation.

B3 Chemist

To work on a research program evaluating the effects of forest management and acid deposition on nutrients in soil, plants, and water. Will take part in the evaluation of forest management practices with respect to conserving soil nutrients and determining the effects of acid deposition on the chemical composition of forest soils, vegetation, soil water, and stream flow. A degree in chemistry and experience in forest management is required.

B4 Engineering Technician

Soil engineering technicians needed to assist engineers in planning, design, or construction work. Also must possess skills and ability to work independently. Will spend a lot of time outdoors helping with surveys, plotting notes, and laying out construction measures. Will also gather data, make computations, and prepare maps and cross sections of profiles. Experience as construction inspector of large structures used for water storage, flood prevention, irrigation, and recreation, desirable. Qualifications include a Bachelor of Science degree in engineering, experience on a survey crew running levels and transits, and experience in construction, layout, and inspection. A sound knowledge of basic mathematics is desirable.

B5 Soil Scientist

The County Extension office seeks a Soil Scientist to work with county farmers. Experience in mapping and classifying soils is a must, along with identifying problems such as wetness and erosion that can limit the ways a soil can be used. Must be able to identify soils on aerial photographs, write soil descriptions, and prepare other information about soils. About 80% of the applicant's time will be spent in the field, with the remaining 20% in the office. Qualifications include a college degree in soil science or a related field of biological, physical, or earth sciences, with a minimum of 15 semester hours in soils.

B6 Range Conservationist

The State of Colorado is looking for a qualified Range Conservationist. Must help plan grazing systems that increase production and prevent overgrazing, suggest ways to control brush, and offer advice on water management or better ways to produce forage. Must have experience and success in custom-designing rangeland conservation plans for large-scale farmers. Applicants must have a bachelor's degree in range management or a closely related field. Studies must have included courses in animal sciences, plant sciences, and soils.

B7 Engineers

The Regional Land Management Bureau seeks engineers who are skilled in erosion control, water management, structural design, construction, hydraulics, soil mechanics, and environmental protection. Applicants can either specialize or work across the board. Preference will be given to applicants with experience in on site planning, designing, and overseeing construction. Duties include work with water supply systems, concrete and earthen dams, and stream bank and channel erosion control. Applicants must have a bachelor's degree in engineering, with experience in agricultural, environmental, civil, and forestry engineering, a plus.

STUDENT HANDOUT 3C

Job Description Ads

Water Related Positions Available

C1 Hydrologist

Study rainfall and flooding patterns in a number of watersheds in natural and urban areas. Be able to work as a team member with experts in other related areas in solving water drainage problems. The person should be able to develop long range studies identifying potential flooding problems and to develop and carry out a plan for eliminating or reducing future damage. A college bachelor's degree in watershed management, hydraulic engineering, or other related area is required.

C2 Interdisciplinary Supervisor (Ketchikan, Alaska)

This employee is the primary assistant to the District Ranger responsible for recreation, lands, public education, soils, hydrology, minerals, cultural resources, and special uses. Supervises a regular staff of 6 and seasonal volunteers.

The major emphasis for this job is the development of Challenge Grant opportunities to develop the district. Presently the district is 838,000 acres and is composed primarily of islands and ocean. Major travel is done by floatplane and boat. Recreation users range from the local residents and subsistence users to cruise ship passengers in town for 4 hours. Current programs include 3 developed campgrounds, 90 miles of trails and a remote cabin program. The national forests are considered a "backyard" by many Southeast Alaskans. Much of our actual work on cabins and trails is accomplished with volunteer work forces from both the local area and the lower 48 states.

The community of Ketchikan has a population of about 12,000 and is serviced by approximately 45 miles of road. Access to the rest of the world is by jet or ferry. The community is full service with a hospital, 4 grocery stores, a small shopping mall, numerous churches, and even a McDonald's. Part of the downtown area is built on piers overlooking Tongass Narrow (saltwater). Primary industries include timber harvest & processing, commercial and sport fishing, and tourism.

C3 Biological Aide

This position is located in a Forest Service unit. The position is a general technical assistant performing routine tasks under a higher graded technician or professional. Major duties include performing and receiving training in a variety of simple and routine tasks; assisting technical or professional personnel in performing various routine field and/or laboratory tests employing standard biological techniques; independently doing routine repetitive tasks on experiments or tests; and assisting in more complex experiments or field work.

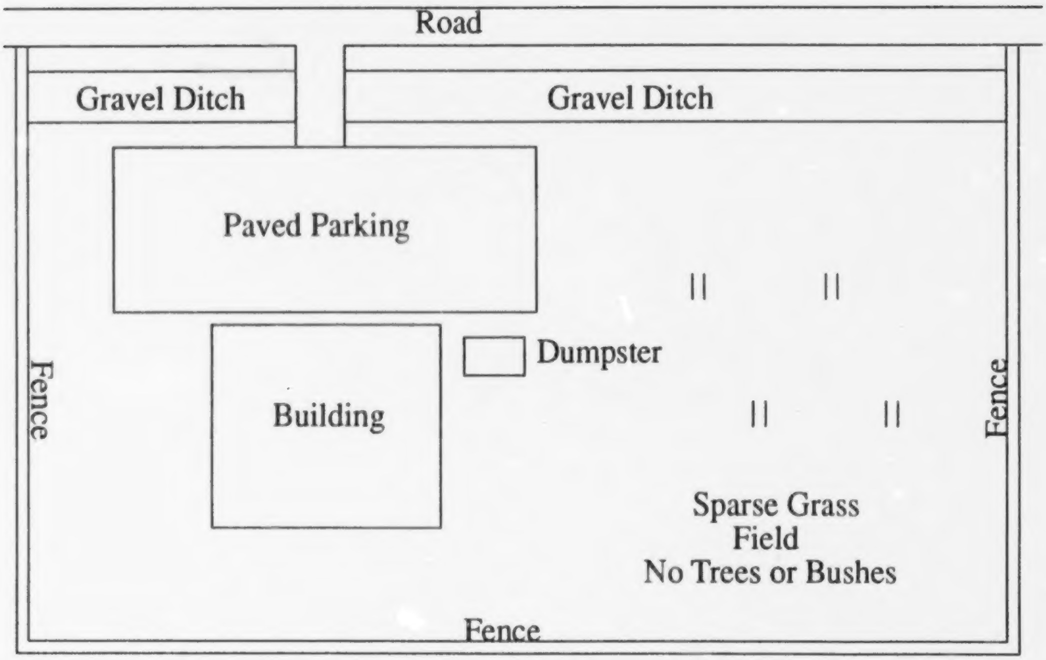
C4 Computer Programmer

This position is located in a Forest Service unit. The incumbent of this position serves as a basic trainee. Major duties include working (as a trainee) with computer programmers performing technical analysis and basic programming duties; operating a terminal and performing limited data entry, editing, program execution, and data retrieval; and operating computer equipment, micro-processors, and data systems; and being involved in a variety of programming applications.

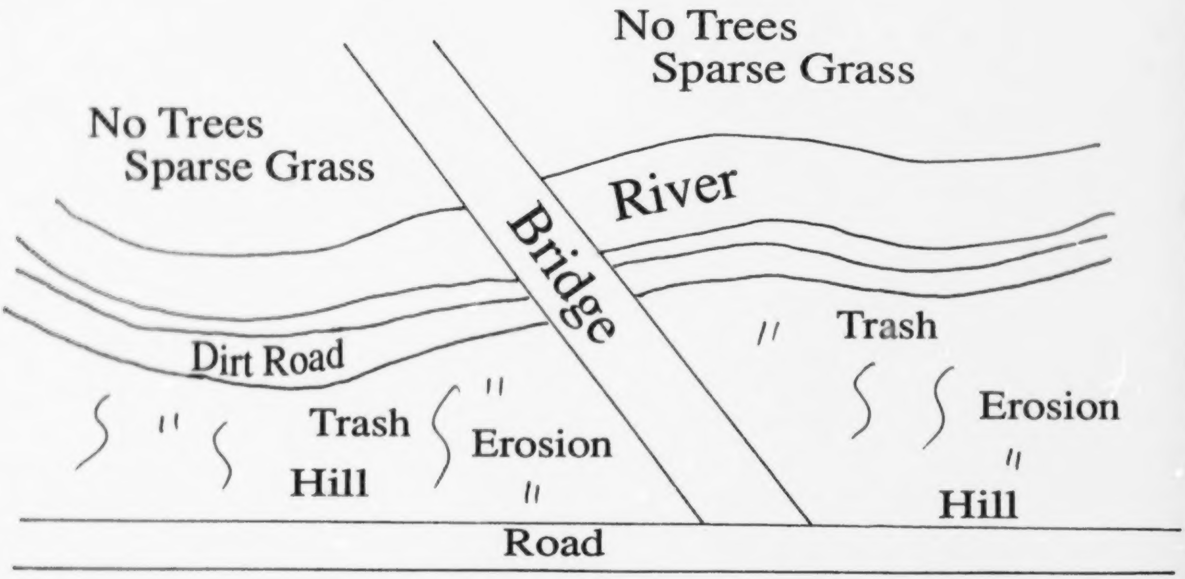
STUDENT HANDOUT 4

Poorly Managed Land

1.


Road
Gravel Ditch
Gravel Ditch
Paved Parking
Dumpster
Building
Fence
Fence
Sparse Grass
Field
No Trees or Bushes
Fence

2.


No Trees
Sparse Grass
No Trees
Sparse Grass
River
Bridge
Dirt Road
Trash
Trash
Erosion
Erosion
Hill
Hill
Road

STUDENT HANDOUT 5

Development Project Cards

1. Surface mine available coal. This action requires roads to be constructed. Include these on your diagram.

2. Harvest timber. This requires that roads be constructed. Locate these on the diagram.

3. Leave part of the area as wilderness and develop recreational use in the remaining parts. Be certain to include any buildings, roads or parking lots on your diagram.

4. Developing recreational use (you select the appropriate type(s)) requires entrance road and parking lot. Your ideas may also require other buildings or trails to make your ideas work. Show these on the diagram.

5. Provide area for hunting and fishing in proper seasons. These uses require an entrance road and parking. Show these on your diagram.

6. Develop part of the land into a recreational area of your choice and part into a commercial use of the natural resources. Be certain to include the roads, parking facilities and buildings on your diagram.

STUDENT HANDOUT 6

Planning the Use of Land

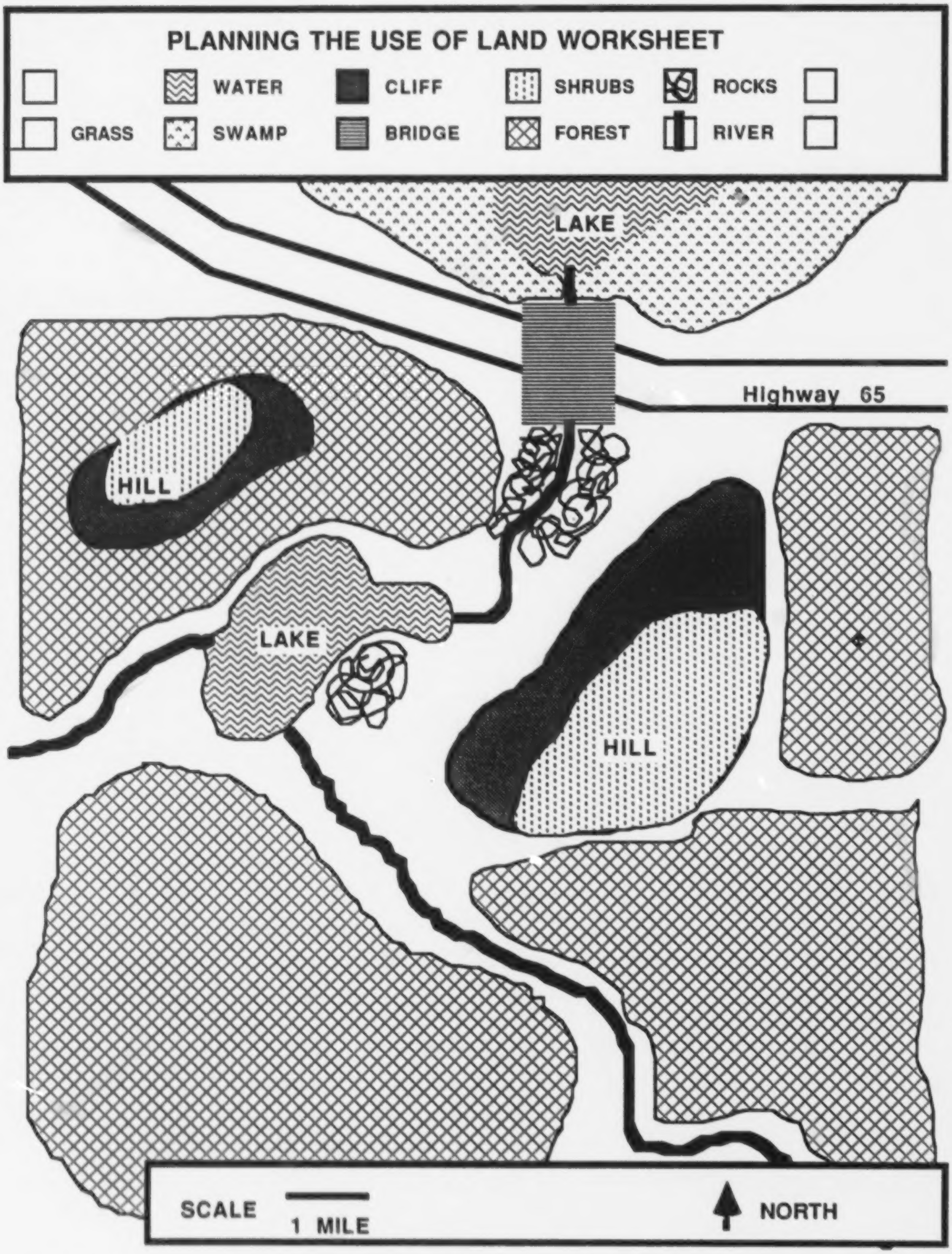
Below is a diagram of a piece of land. You are to decide how this land can be used. The legend tells what the symbols on the diagram represent. Notice that there is some extra space in the legend where you will add symbols that describe your choice for the use of different parts of the land. Draw the symbols in the legend and also on the diagram where you wish to locate your projects. Choose two of the following that are suggested. When you complete your planning map you will be asked to share it with the class and give reasons for your choices and the locations of projects.

The following projects have been suggested:

1. Surface mining of available coal. This action requires roads to be constructed. Include these on your diagram.
2. Harvesting timber requires that roads be constructed . Locate these on the diagram.
3. Leave an area as wilderness. This requires selling the idea to large numbers of people and eliminating traffic in the wilderness area.
4. Develop recreational use (you select the appropriate type(s)). This requires an entrance road and a parking lot. This may also require other buildings, trails, and an information center.
5. Provide an area for hunting and fishing in proper seasons. This requires an entrance road and parking.
6. Develop this area for a large shopping mall and for recreation. This may require leveling the hills, filling in the lake, building parking lots, a drainage system, and buildings.

See map on next page.

PLANNING THE USE OF LAND WORKSHEET


WATER
CLIFF
SHRUBS
ROCKS
GRASS
SWAMP
BRIDGE
FOREST
RIVER
LAKE
Highway 65
HILL
LAKE
HILL
SCALE
1 MILE
NORTH

STUDENT HANDOUT 7

Job Descriptions for Use of a Large Land Area

Based on the development project you have just completed, write at least three job descriptions for people who would work in this project. In your descriptions of each include the following:

1. A name for the job that describes the work.
2. The duties that the person performs.
3. The special requirements for the position in training or education.
4. The hours the employee works and the salary.

Position Description 1

Position Description 2

Position Description 3